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Ultrathin Free Flaps to the Foot and Ankle: New Options for Optimal Soft Tissue Coverage and Functional Contour

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ABSTRACT

Soft tissue defects and chronic wounds around the foot and ankle can prove difficult to reconstruct using conventional techniques. Traditional flaps used for coverage in this region can result in the need for future debulking, shoe gear modifications, donor site morbidity, decreased function, and scarring. Successful reports of ultrathin free flaps harvested along suprafascial planes have yet to be described in the foot and ankle literature. We present 2 cases of ultrathin flaps used for foot and ankle defects that provide optimal contour while not limiting anatomic function. The resultant functional outcomes and contour shown by both flaps underscore the benefit of a thin and pliable flap in this region.

Wounds of the lower extremity can be difficult to treat and can lead to amputation. Efforts to prevent lower extremity amputation are often impeded by issues involving bony stability, soft tissue coverage, partial or total restoration of function, and eventual skin closure. Amputation is associated with increased morbidity and cost utilization compared with limb salvage (1–6). Despite a wide array of osseous fixation and grafting techniques (7–10), soft tissue closure remains a challenging problem in the treatment of distal lower extremity wounds.

Traditional soft tissue flap options for the distal lower extremity are fasciocutaneous flaps or muscle flaps combined with skin grafts. Flap options are diverse and well described (11,12); however, some of these options are problematic because they may require debulking or shoe modifications and can lead to decreased function, scarring, and donor site morbidity (13,14). Skin grafts healed on the superficial surface of muscle flaps can be unstable in long-term evaluation and are prone to breakdown with shear force (15,16). Recent literature has suggested increased use of flap options that are more consistent with the soft tissue thickness of the lower leg and foot, with durable skin and dermis to promote durability (17–19). In the distal lower extremity, few options meeting these criteria exist in conventional flap harvest techniques.

The suprascarpal superficial circumflex iliac artery perforator (SCIP) and suprascarpal anterolateral thigh (ALT) ultrathin flaps have been described as able to provide adequate, thin, soft tissue coverage of the lower extremity while maintaining low donor-site morbidity (18,20,21). Here, we present 2 cases of soft tissue defects of the foot and ankle successfully repaired with ultrathin SCIP and ALT flaps, resulting in functional outcomes.

Case Series

Surgical Technique and Planning

Dissection of a thin perforator flap requires strategic vessel mapping given the small caliber of the supplying vasculature. In the case of both the ultrathin flap options, standard flap markings based on the angiosome of the feeding vessel are made. Dissection of conventional flaps is in the subfascial plane. Planar dissection in the suprascarpal plane allows for the flap thickness to be ~50% to 80% of the thickness of conventional flaps from the same area. The dissection plane is hallmarked by a transition of fibrous fat (suprascarpal fat) and loose, globular fat (subscarpal fat). Vessel identification at this level is carefully approached with meticulous handling because this is crucial to the harvest to avoid spasm and loss of blood supply. The skin territory irrigated

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Fig. 1. Surgical wound with exposed sinus tarsi, subtalar joint, and peroneal tendon after resection of soft tissue necrosis from seroma.

by the source vessels of these flaps has multiple perforators that are able to be harvested with the flap.

Case 1

A 30-year-old male was involved in a motor vehicle accident, sustaining polytrauma injury including a devastating lower extremity injury. Initial fracture fixation was complicated by wound formation and hardware exposure (Fig. 1). Flap planning began for coverage of the wound. The patient underwent preoperative angiography for vessel mapping, given concerns for delayed vascular flow in the setting of polytrauma to the lower extremity. Patent flow was found in both posterior tibial and peroneal vessels, with retrograde filling of the dorsalis pedis vessel as well (Fig. 2).

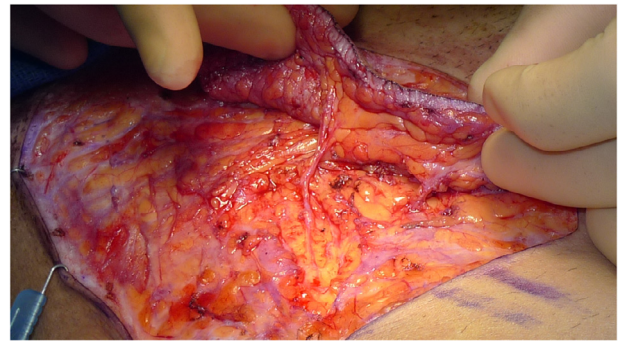

Fig. 3. Elevation of the suprascarpal superficial circumflex iliac artery perforator flap with lateral and medial perforators identified.

Recipient site exposure was first performed to determine usability of the inflow vessel. In this case, an angiogram confirmed the presence of the lateral tarsal artery, which was in close proximity to the wound. This vessel with the vena comitante was prepared. Following this, the SCIP flap with a 12 × 6-cm cutaneous paddle was chosen from the contralateral groin after Doppler signals of the perforating vessel were identified. Dissection of the flap began at the following predetermined markings from laterally near the anterior-superior iliac spine toward the source vessels (Fig. 3). Two perforators emanating from the superficial circumflex iliac vessels were isolated (Fig. 4). An end-to-side anastomosis technique was used to the lateral tarsal vessels with 10-0 nylon suture. Venous anastomosis was then performed with 10-0 nylon suture in an end-end configuration (Fig. 5). The patient was seen at 2, 4,

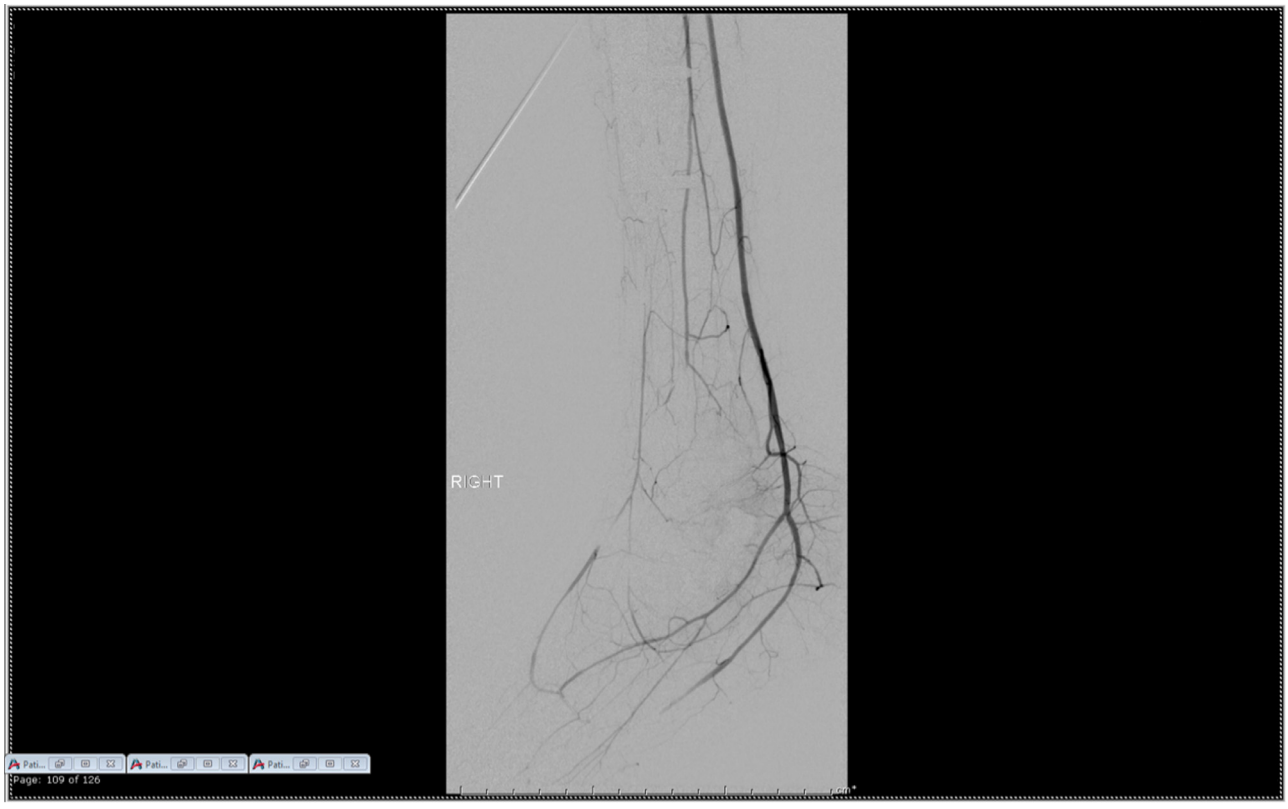

Fig. 2. Angiography for vessel mapping. Patency of the posterior tibial and peroneal arteries is seen.

Fig. 4. Profile view of the suprascarpal superficial circumflex iliac artery perforator flap with a pedicle. Intraoperative thickness is measured at 7 mm.

Fig. 5. The inset flap with minimal bulk after anastomosis is complete.

and 6 weeks postoperatively in clinic, where both the flap and donor sites were found to have appropriate healing. At the 6-month follow-up visit, the patient was able to return to work after undergoing physical therapy (Fig. 6). During the latest follow-up visit at 2 years, the patient was wearing a normal shoe, the same size as the uninjured foot.

Case 2

A 62-year-old female with a history of diabetes and venous stasis disease had a long-standing chronic wound with an underlying venous malformation (Fig. 7). The patient underwent excision of the venous lesion with microsurgical flap closure using an ultrathin ALT flap. First, the venous malformation was removed, leaving a large soft tissue defect measuring 10 × 12 cm (Fig. 8). After identification of recipient vessels (posterior tibial artery/vein), a plan was made for an ALT flap. Modified dissection of this flap allowed for planar dissection in the suprascarpal plane from lateral to medial to identify usable perforators. The full thickness of the thigh measured ~5 cm. The flap thickness was <1 cm in thickness (Fig. 9). Fluorescence angiography was performed to confirm inflow to the flap. The patient was given protected weightbearing status in a walking boot for 4 weeks after surgery. At the 1-year follow-up visit (Fig. 10), the patient had complete flap incorporation with wound closure and minimal complications and was wearing a normal shoe, the same size as her unaffected foot. The patient is now 2 years postsurgery in similar good condition.

Discussion

Closure of soft tissue defects in the lower extremity can be challenging for the foot and ankle surgeon in certain circumstances. The presence of comorbidities including smoking, peripheral vascular disease, renal insufficiency, and diabetes can exacerbate the process of expedient wound closure (18,22–25), making it incumbent on the provider to explore alternative options when primary closure fails. The ultrathin free flap is a creative option using conventional flap techniques to provide durable soft tissue coverage that is thin and pliable (14,19,20). The SCIP flap has been shown to overcome the disadvantage of conventional flaps, including the concealment of donor site scars, easy primary closure of the donor site, availability of large cutaneous paddles, minimal flap bulk, decreased donor site numbness, and decreased dissection time (26). Its versatility has been reported in the pediatric population as well, providing sensate free flap coverage in a 1 year old (27) and after complex reconstruction following total ankle arthroplasty (28). In addition, the ALT flap is considered a workhorse flap for soft tissue

Fig. 6. Incorporated flap at the 6-month follow-up visit.

Fig. 7. Venous malformation of the medial ankle with chronic ulceration.

Fig. 9. Profile view during elevation of the anterolateral thigh flap. Proximal and distal perforators are visualized.

Fig. 8. Soft tissue void after resection of the malformation.

coverage around the body. Applications have included flow-through flaps for revascularization, vascularized fascia lata for single-stage tendon reconstruction, functional muscle transfer, sensate flaps, and chimeric flaps for extensive composite defects (29). In Western societies, the anterior thigh region may have a significant thickness, which prevents surgeons from using this donor site for the foot and ankle region. The ultrathin modification to this flap allows for improved contouring and pliability that is needed in the foot and ankle. Ultrathin dissection of this flap can result in a close match to the subcutaneous and skin thickness of the foot and ankle (30).

This case series reports on successful treatment of soft tissue defects using unique free flap options that have shown specific utility and benefit to the foot and ankle. Neither patient required custom-made or oversized shoe gear, and both were able to resume normal activity after flap coverage in a single-stage surgery. The ultrathin flap provides soft tissue coverage while allowing superior anatomic contour and pliability for the distal lower extremity without the need for skin grafts. Multidisciplinary care

Fig. 10. Incorporated flap at the follow-up visit.

between surgical teams is a crucial component to lower extremity reconstruction and requires an understanding of innovative treatment paradigms to improve patient-centered outcomes.

References

1. Mayfield JA, Reiber GE, Maynard C, Czerniecki JM, Caps MT, Sangeorzan BJJ. Survival following lower-limb amputation in a veteran population. Rehabil Res Dev 2001;38:341–345.
2. Yasar E, Tok F, Kesikbrurn S, Ada AM, Kelle B, Goketpe AS, Yazıcıoğlu K, Tan AK. Epidemiologic data of trauma-related lower limb amputees: a single center 10-year experience. Injury 2017;48:349–352.
3. Chung KC, Saddawi-Konefka D, Haase SC, Kaul G. A cost-utility analysis of amputation versus salvage for Gustilo type IIIB and IIIC open tibial fractures. Plast Reconstr Surg 2009;124:1965–1973.
4. Driver VR, Fabbi M, Lavery LA, Gibbons G. The costs of diabetic foot: the economic case for the limb salvage team. J Vasc Surg 2010;52(3 suppl):17–22.
5. Centers for Disease Control and Prevention. National Diabetes Statistics Report: Estimates of Diabetes and Its Burden in the United States, 2014. Centers for Disease Control and Prevention, Atlanta, GA:2014.
6. Armstrong DG, Kanda VA, Lavery LA, Marston W, Mills JL Sr, Boulton AJ. Mind the gap: disparity between research funding and costs of care for diabetic foot ulcers. Diabetes Care 2013;36:1815–1817.
7. Yazar S, Lin C-H, Wei F-C. One-stage reconstruction of composite bone and soft-tissue defects in traumatic lower extremities. Plast Reconstr Surg 2004;114:1457–1466.
8. Chapman MW, Mahoney M. The role of early internal fixation in the management of open fractures. Clin Orthop Relat Res 1979;138:120–131.
9. Yaremchuk MJ, Brumback RJ, Manson PN, et al. Acute and definitive management of traumatic osteocutaneous defects of the lower extremity. Plast Reconstr Surg 1987;80:1–14.
10. Zalavras CG, Patzakis MJ. Open fractures: evaluation and management. J Am Acad Orthop Surg 2003;11:212–219.
11. Saint-Cyr M, Wong C, Buchel EW, Colohan S, Pederson WC. Free tissue transfers and replantation. Plast Reconstr Surg 2012;130:858e–878e.
12. Burtt KE, Rounds AD, Leland HA, Alluri RK, Patel KM, Carey JN. Patient and surgical factors contributing to perioperative infection in complex lower extremity trauma. Am Surg 2016;82:940–943.
13. Parmaksizoğlu AF, Unal MB, Cansü E. The reconstruction of foot soft tissue defects by tangential debulking of the latissimus dorsi flap. J Reconstr Microsurg 2011;27:211–214.
14. Demirtas Y, Neimetzade T, Kelahmetoglu O, Guneren E. Comparison of free muscle and perforator skin flaps for soft tissue reconstruction of the foot and ankle. Foot Ankle Int 2010;31:53–58.
15. Maisels DO. Repair of the heel. Br J Plast Surg 1961;14:117.
16. Sommerlad BC, McGrouther DA. Resurfacing the sole: long-term follow-up and comparison of techniques. Br J Plast Surg 1978;31:107.
17. Medina MA III, Salinas HM, Eberlin KR, Driscoll DN, Kwon JY, Austen WG Jr, Cetrulo CL Jr. Modified free radial forearm fascia flap reconstruction of lower extremity and foot wounds: optimal contour and minimal donor-site morbidity. J Reconstr Microsurg 2014;30:515–522.
18. Seth AK, Iorio ML. Super-thin and suprafascial anterolateral thigh perforator flaps for extremity reconstruction. J Reconstr Microsurg 2017;33:466–473.
19. Hong JP, Choi DH, Suh H, Mukarramah DA, Tashti T, Lee K, Yoon C. A new plane of elevation: the superficial fascial plane for perforator flap elevation. J Reconstr Microsurg 2014;30:491–496.
20. Hong JP, Sun SH, Ben-Nakhi M. Modified superficial circumflex iliac artery perforator flap and supermicrosurgery technique for lower extremity reconstruction: a new approach for moderate-sized defects. Ann Plast Surg 2013;71:380–383.
21. Goh TL, Park SW, Cho JY, Choi JW, Hong JP. The search for the ideal thin skin flap: superficial circumflex iliac artery perforator flap—a review of 210 cases. Plast Reconstr Surg 2015;135:592–601.
22. Greenhalagh DG. Wound healing and diabetes mellitus. Clin Plast Surg 2003;30:37–45.
23. Maroz N, Simman. Wound healing in patients with impaired kidney function. J Am Coll Clin Wound Spec 2014;5:2–7.
24. Zhan LX, Branco BC, Armstrong DG, Mills JL Sr. The Society for Vascular Surgery lower extremity threatened limb classification system based on Wound, Ischemia, and foot Infection (WIfI) correlates with risk of major amputation and time to wound healing. J Vasc Surg 2015;61:939–944.
25. Patel KM, Economides JM, Franklin B, Sosin M, Attinger C, Ducic I. Correlating patient-reported outcomes and ambulation success following microsurgical lower extremity reconstruction in comorbid patients. Microsurgery 2014;34:1–4.
26. Muller CW, Krettek C, Decker S, Kankemeier S, Hawi N. [Limb salvage or amputation after sever trauma to the lower extremities: evidence from the LEAP study]. Unfallchirurg 2016;119:400–407.
27. Hsu WM, Chao WN, Yang C, Fang CL, Huang KF, Lin YS, Lee TH. Evolution of the free groin flap: the superficial circumflex iliac artery perforator flap. Plast Reconstr Surg 2007;119:1491–1498.
28. Lida T, Yamamoto T, Yoshimatsu H, Abe N, Tsuchiya M, Nemoto N, Watanabe S. Supermicrosurgical free sensate superficial circumflex iliac artery perforator flap for reconstruction of a soft tissue defect of the ankle in a 1-year-old child. Microsurgery 2016;36:254–258.
29. Yamamoto T, Saito T, Ishiura R, Lida T. Quadruple-component superficial circumflex iliac artery perforator (SCIP) flap: a chimeric SCIP flap for complex ankle reconstruction of an exposed artificial joint after total ankle arthroplasty. J Plast Reconstr Aesthet Surg 2016;69:1260–1265.
30. Dayan JH, Lin CH, Wei FC. The versatility of the anterolateral thigh flap in lower extremity reconstruction. Handchir Mikrochir Plast Chir 2009;41:193–202.