Sensory and Functional Recovery after Suprafascial Free Flap in Foot and Ankle Reconstruction

Nutthawut Akaranuchat, MD[1] Natthapong Kongkunnavat, MD[1]

[1] Division of Plastic Surgery, Department of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand

J Reconstr Microsurg Open 2023;8:e81–e87.

Address for correspondence Nutthawut Akaranuchat, MD, Division of Plastic Surgery, Department of Surgery, Clinical Lecturer of Surgery, Faculty of Medicine Siriraj Hospital, Mahidol University, 2 Wanglang Road, Bangkok Noi, Bangkok 10700, Thailand (e-mail: nutthawut.aka@mahidol.ac.th).

Abstract

Background The goals of foot and ankle defect reconstruction include weight-bearing and shearing tolerance, good mobilization, regaining protective sensation, and good contour for footwear fitting. This study reports the outcomes of foot and ankle defect reconstruction with suprafascial free flaps relative to sensory and functional recovery.

Methods Eleven suprafascial free flaps were performed, which were supra-Scarpa fascial flaps in seven cases. Sensory recovery was assessed by Semmes-Weinstein monofilament test (SWMT), and functional outcomes were measured using the Foot and Ankle Ability Measure (FAAM) questionnaire at preoperative and subsequent visits.

Results Eleven cases (age range: 21–83 years, seven males, mean body mass index: 24.8 kg/m^2) were operated and the mean defect size was 109.8 cm^2. The anterolateral thigh, medial sural artery perforator, and superficial circumflex iliac artery perforator flaps were used. The mean flap thickness was 0.8 cm. Average flap harvesting time and operative time were 83.9 and 452.0 minutes. Half of cases achieved 10 g SWMT (two cases regained baseline sensation) by 6-months post-operation, and all cases regained either 10 g SWMT or baseline sensation within 12 months. Significant improvement in the activities of daily living (ADL) and sports subscales was observed at 3 months ($p < 0.05$). Significant improvement in the global function rating scale for both ADL and sports was achieved by 6 months ($p < 0.05$). None experienced the recurrent ulcer.

Conclusion Suprafascial free flap is a good reconstruction strategy for managing complex foot and ankle defects that yields favorable outcomes including adequate protective sensation and significant functional improvement.

Keywords
- suprafascial free flap
- reconstruction
- sensation
- functional outcomes
- lower extremity

Microvascular free tissue transfer has become a reconstructive technique of choice for many types of major defect reconstruction. There have been numerous reports about the outcomes of microvascular free tissue transfer since 1960s.[1–5] Several studies recommended this surgical technique as a suitable treatment alternative for managing complicated defects, and that it yields favorable results.[6–17] Soft tissue defects of the foot and ankle pose one of the greatest challenges for reconstructive surgeons. This region is associated with several specific goals of reconstruction, including durability for weight-bearing and shearing tolerance, adequate protective sensation to prevent

received
January 12, 2022
accepted after revision
May 29, 2022

DOI https://doi.org/10.1055/s-0042-1757322.
ISSN 2377-0813.

Thieme Medical Publishers, Inc., 333 Seventh Avenue, 18th Floor, New York, NY 10001, USA

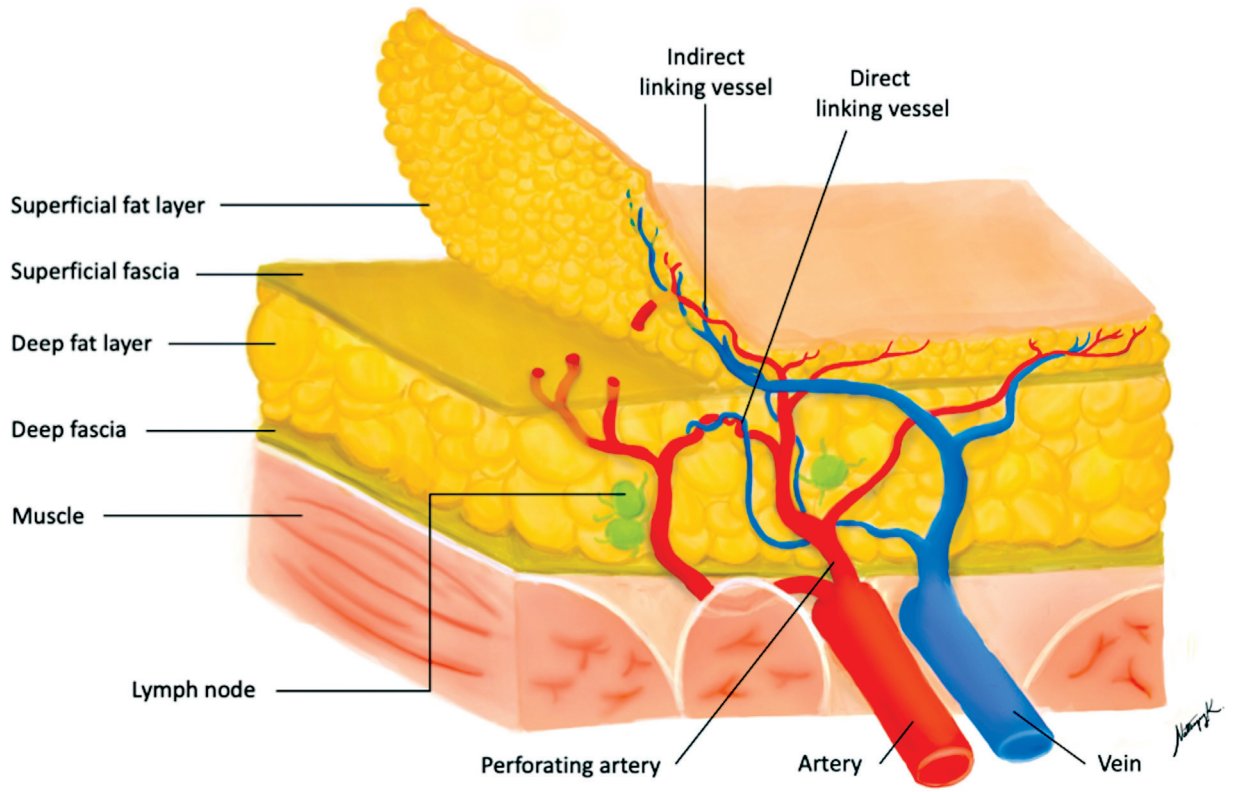

Fig. 1 The important layers for thin fasciocutaneous flap harvesting. Five layers, including skin, superficial fat layer, superficial fascia, deep fat layer, and deep fascia, should be identified. The superficial fat and deep fat are separated by superficial fascia. Dissection at the plane above the superficial fascia is referred to as a thin supra-Scarpa fascial flap.

recurrent ulcer, appropriate flap thickness to facilitate mobilization, and good postoperative contour for the fitting of footwear.[18–20]

At our center, we started managing complex lower extremity defects with microvascular free tissue transfer in 1992. Most of the flaps inset since that time successfully survived, but the sufficiency of sensory recovery and functional outcomes is still being questioned.[21] Narushima, et al[22] recently published a classification of thin flaps that is based on the anatomical plane of dissection. Hong and Chung[23] demonstrated the safely plane of flap dissection at the plane of superficial fascia which refers to thin flaps as we called today (►**Fig. 1**).

Soft tissue free flaps can now be harvested thinner to appropriately match case-specific requirements. The aim of this study was to analyze and report the sensory and functional outcomes of patients who underwent foot and ankle defect reconstruction with thin suprafascial free flap. The results of postoperative functional outcomes were assessed by using the validated tool called Foot and Ankle Ability Measure (FAAM), which globally assessed the foot and ankle in various aspects of patient activities.

Methods

The protocol for this prospective study was approved by the Institutional Review Board (COA no. 600/2563). Written informed consent was obtained from all study patients. Patients who underwent thin suprafascial free flap surgery for foot and ankle defect reconstruction by a single surgeon at the Division of Plastic and Reconstructive Surgery of the Department of Surgery during January 2018 to March 2021 were enrolled. Demographic and clinical data, including age, gender, body mass index (BMI), underlying disease, American Society of Anesthesiologists (ASA) classification, were collected. Operative details, such as indication for surgery, defect and flap dimension, operative time, vessels and type of anastomosis, ischemic time, flap-success rate, and complications, were also recorded. The perforator of donor vessel(s) was preoperatively assessed by handheld Doppler and duplex ultrasound. All flaps were harvested using either suprafascial or supra-Scarpa fascial plane approach. Total operative time was defined as the time between first incision and wound closure. Ischemic time was defined as the time from transection of the vascular pedicle to complete arterial anastomosis and release of the vascular clamp.[20] After surgery, clinical free flap monitoring was performed until postoperative day 7. All patients were instructed to ambulate in a non-weight bearing manner for 1 week, and full-weight bearing was scheduled to begin at 2-weeks postoperatively.

Sensory perception was measured by Semmes-Weinstein monofilament test (SWMT).[24,25] The test was performed before surgery, and at 3, 6, 12, 18, and 24 months after surgery. The sensory response of the area next to the surgical site was also recorded before surgery because some lesions or defects could cause more regional sensory disturbance that would distort our evaluation of flap sensory recovery.

Functional outcomes were subjectively assessed using the FAAM questionnaire, which comprises four subscales,

including the activities of daily living (ADL) subscale, the Global function rating scale for ADL, the sports subscale, and the Global function rating scale for sports. FAAM assessment was performed before surgery, and at 3, 6, 12, 18, and 24 months after surgery. A higher FAAM score indicates a higher level of physical function and more capability to perform ADL.[26,27]

Data Assessment

Statistical analysis of the data was performed using the PASW Statistics for Windows, Version 18.0 (SPSS Inc., Chicago, IL). Data are presented as mean and range, mean ± standard deviation, or number and percentage. Paired *t*-test was used to compare differences in sensory recovery and FAAM scores between baseline and follow-up values. A *p*-value equal to or less than 0.05 was regarded as being statistically significant.

Results

The data from 11 patients who underwent thin suprafascial free flap for foot and ankle defect reconstruction were analyzed. The average age of patients was 58.5 years (range: 21–83), there were seven men, and mean BMI was 24.8 kg/m^2 (range: 19.0–42.7). Five patients had hypertension (45.5%), four had diabetes mellitus (36.4%), and two had dyslipidemia (18.2%) as comorbidities. ASA classification I, II, and III was found in 27.3, 36.4, and 36.4% of patients, respectively (►**Table 1**).

The majority of defects were at the heel (4 of 11, 36.4%), followed by the forefoot and dorsum (3 of 11, 27.3%), and midfoot (2 of 11, 18,2%). Regarding etiology, seven (63.6%) defects resulted from tumor eradication, three (27.3%) from trauma, and one from necrotizing fasciitis (9.1%). The average defect size was 109.8 cm^2 (6.0 × 4.0–25.0 × 15.0 cm^2). The types of thin free flaps used in this study were anterolateral thigh (ALT) free flap in five cases (45.5%), medial sural artery perforator (MSAP) free flap in four cases (36.4%), and superficial circumflex iliac artery perforator free flap in two cases (18.2%). The average flap size was 145.8 cm^2 (7.5 × 7.0–25.0 × 17.0 cm^2) with 0.8 cm mean thickness (range: 0.5–2.0). The average vascular pedicle length was 8.3 cm (range: 4.0–10.0). The recipient arteries used for anastomosis were posterior tibial artery in four cases (36.4%), dorsalis pedis artery (DPA) in four cases (36.4%), anterior tibial artery in two cases (18.2%), and lateral plantar artery in one case (9.1%). The mean diameter was 2.0 mm (range: 1.2–4.3) for the donor artery, 2.5 mm (range: 1.5–3.7) for the recipient artery, 2.4 mm (range: 1.4–3.5) for the donor vein, and 2.5 mm (range: 1.8–3.5) for the recipient vein. Seven cases (63.6%) were performed with one arterial and two venous anastomoses. The sensory nerves of flaps were not anastomosed, but the authors harvested the flap thinly to allow transmitting forces to underlying structures. The donor sites in most cases could be closed primarily (7 of 11 cases, 63.6%). The mean duration of the total operative time was 452 minutes (range: 340–660), and the mean flap harvesting time was 83.9 minutes (range: 68–130). The mean ischemic time was 57.4 minutes (range: 42–106). The average length of hospital stay was 16.3 days (range: 6–30) (►**Figs. 2** and **3**).

After surgery, two cases (BMI of 33.1 and 42.7 kg/m^2, respectively) required some flap debulking, which was performed under local anesthesia. Partial flap wound dehiscence was found in two cases, which was also managed under local anesthesia. The mean follow-up time was 18.2 months, and no serious donor site morbidity or recurrent ulcer was observed or reported at the flap area during the follow-up period (►**Table 2**). One of our 11 cases was excluded from the sensory and functional evaluation

Table 1 Patient demographic and clinical characteristics

	Mean	Range
Age (years)	58.5	21–83
Weight (kg)	66.0	50.0–100.0
Height (m)	1.6	1.5–1.8
BMI (kg/m^2)	24.8	19.0–42.7
	n	%
Sex		
Male	7	63.6
Female	4	36.4
Underlying		
Hypertension	5	45.5
Diabetic mellitus	4	36.4
Dyslipidemia	2	18.2
Obesity	2	18.2
Coronary artery disease	1	9.1
Meningomyelocele	1	9.1
ASA classification		
Class 1	3	27.3
Class 2	4	36.4
Class 3	4	36.4

Fig. 2 An 83-year-old Thai female presented with melanoma at her right heel. (**A**) The defect size after tumor eradication was 13 × 8 cm, with some area exposed to calcaneus. (**B**) A contralateral suprafascial medial sural artery perforator free flap was designed and harvested by elevation at the subcutaneous plane above the fascia. (**C**) The flap was inset and anastomosed with posterior tibialis vessels.

Fig. 3. By 12 months after surgery, she regained protective sensation of 10 g as assessed by Semmes Weinstein monofilament test, and she can ambulate by herself and perform activities of daily living with no difficulty (**A–E**).

analyses at the 2-month follow-up time point due to an inability to travel to our center as a result of COVID-19 travel restrictions. Sensory and function recovery were assessed in the remaining10 patients.

Sensory Recovery

At 3 months after surgery, one case achieved protective sensation at 10 g SWMT, but no patients recovered their preoperative sensation level. Half of patients achieved protective sensation at 10 g SWMT by 6 months. The other five of 10 cases achieved only 300 g SWMT by the 6-month time point; however, three of those patients improved their sensation to 10 g SWMT by the 12-month postoperative time point. And for the other two patients, we assume that they will still sensate only 300 g SWMT which is equal to their base line preoperative sensation (►**Table 3**).

Functional Recovery

The FAAM ADL scores were statistically significantly improved in all patients by 3 months after surgery when compared to baseline values ($p < 0.05$). The FAAM Global function rating scale for ADL was statistically significantly improved in all patients by 6 months after surgery when compared to baseline values ($p < 0.05$) (►**Supplementary Tables S1** and **S2**). The FAAM for sports was statistically significantly improved in all patients by 3 months after surgery when compared to baseline values ($p < 0.05$). The FAAM Global function rating scale for sports was statistically significantly improved by 6 months after surgery when compared to baseline values ($p < 0.05$) (►**Supplementary Tables S3** and **S4**). Continued improvement was observed overtime for most patients in all subscales. All FAAM subscales were significantly improved by 6 months after surgery (all $p < 0.05$) (►**Table 4**).

Discussion

Microvascular free-tissue transfers have become the preferred reconstructive technique for managing complex wounds and surgical defects, especially in lower extremity defect reconstruction. In this study, thin suprafascial free flaps were used to cover defects at the foot and ankle region. A thin ALT free flap created using the supra-Scarpa fascia approach is our flap of choice for dealing with complex lower extremity defects. This flap allows for a thin and sizeable skin paddle, long pedicle length, low-risk of donor site morbidity, and modification capability, such as including the fascia latae or vastus lateralis muscle with the flap when needed.[28]

Table 2 Free flap-related details

	n	%
Site of defect		
Heel	4	36.4
Forefoot and dorsum	3	27.3
Midfoot	2	18.2
Forefoot	1	9.1
Forefoot and midfoot	1	9.1
Cause of defect		
Tumor ablation	7	63.6
Trauma	3	27.3
Infection	1	9.1
Type of flap		
ALT free flap	5	45.5
MSAP free flap	4	36.4
SCIP free flap	2	18.2
Flap successive rate	11	100.0
Adverse events		
Flap revision[a]	1	9.1
Wound dehiscence	2	18.2
Flap debulging	2	18.2
Recurrent ulcer	0	0.0
Donor site closure		
Primary closure	7	63.6%
Split-thickness skin graft	4	36.4%
	Mean	**Range**
Defect and flap dimension		
Defect size (cm^2)	109.8	6.0×4.0–25.0×15.0
Flap area (cm^2)	145.8	7.5×7.0–25.0×17.0
Flap thickness (cm)	0.8	0.5–2.0
Pedicle length (cm)	8.3	4.0–10.0
Timing details		
Flap harvesting time (min)	83.90	68–130
Ischemic time (min)	57.40	42–106
Operative time (min)	452	340–660
Follow-up time (months)	18.18	6–29
Length of hospital stay (days)	16.27	6–30
	n	%
Anastomosis details		
Recipient artery		
PTA	4	36.4
DPA	4	36.4
ATA	2	18.2
LPA	1	9.1
Anastomosis type		
End to end	11	100.0
A:V ratio		
1A:2V	7	63.6
1A:1V	4	36.4
	Mean	**Range**
Vessel diameter		
Donor artery (mm)	2.0	1.2–4.3
Recipient artery (mm)	2.5	1.5–3.7
Donor vein (mm)	2.4	1.4–3.5
Recipient vein (mm)	2.5	1.8–3.5

Abbreviations: ALT, anterolateral thigh; ATA, anterior tibial artery; DPA, dorsalis pedis artery; LPA, lateral plantar artery; MSAP, medial sural artery perforator; PTA, posterior tibial artery; SCIP, superficial circumflex iliac artery perforator.
[a]Flap revision due to artery insufficiency with successful flap salvaging.

Despite the very low case number, the results might suggest that suprafascial free flap approach is safe and does not produce any negative effects to flap survival.[21] Moreover, in the present study, no serious complication or recurrent ulcer was observed or reported. As in published literatures, the suprafascial flaps yield is a safe and effective choice for soft tissue reconstruction of foot and ankle.[29–31] The benefits of these thin flaps result in good pliability and contour, and decrease the need of postoperative thinning procedure from flaps bulkiness.[29,31]

In this study, two of eleven cases, which had BMIs of 33.1 and 42.7 kg/m^2, respectively, underwent flap debulking by liposuction and partial resection at 1 month after surgery, which yielded good outcomes in both form and function within a few months. One patient was unable to attend a follow-up for sensory and functional assessment, so that patient was excluded from those analyses.

For the outcomes of sensory recovery, all patients regained their protective sensation to reach 10 g SWMT by 12 months after surgery, except two cases that had abnormal baseline sensation. This suggests the importance of counseling patients to avoid any trauma to the reconstruction area for 1 year after reconstruction when protective sensation regained.

Regarding the subjective FAAM questionnaire, the ADL and sports subscales were all significantly improved at 3 months after surgery compared to baseline. Significant improvement in the Global function rating scale for ADL and the Global function rating scale for sport subscales was observed at 6 months after surgery compared to baseline. These findings suggest that we counsel patients to beware of injury or accident that could occur during the first 6 months after surgery due to impaired foot and ankle function. At last, patients could achieve more than 80% of their Global function rating scale for ADL by 6 months and Global function rating scale for sport at 24 months after surgery. All of these

Table 3 Sensory recovery as evaluated by Semmes-Weinstein monofilament test (grams)

Case	Pre-op	Nearby	3 mo	6 mo[a]	12 mo[a]	18 mo	24 mo
1	4	4	300	10	10	NA	NA
2	2	2	> 300	300	10	10	10
3	10	2	300	10	10	10	10
4	10	2	> 300	300	10	10	10
5	4	2	300	10	4	4	NA
6	> 300	10	300	300	10	10	NA
7	2	4	10	10	10	NA	NA
8	> 300	300	> 300	300	NA	NA	NA
9	> 300	2	> 300	10	NA	NA	NA
10	> 300	300	300	300	NA	NA	NA

Note: At 6 months after surgery, 50% of patients achieved sensation threshold at 10 g level. Furthermore, all the patients achieved adequate sensation level for lower extremity at 12 months follow-up, which was at 10 g level in 85.7% and at 4 g level in 14.3%.

Table 4 Foot and Ankle Ability Measure (FAAM) score at each follow-up time point

Timing	ADL subscale	*p*	Global ADL (%)	*p*	Sports subscale	*p*	Global sports (%)	*p*
Pre-op	51.67 ± 24.54		55.00 ± 37.19		30.85 ± 27.37		30.00 ± 35.28	
3 m	72.54 ± 16.02	0.036	65.00 ± 26.25	0.472	61.58 ± 31.69	0.010	44.50 ± 37.30	0.071
6 m	85.91 ± 9.81	0.003	85.00 ± 10.80	0.033	76.44 ± 19.43	0.000	68.5 ± 25.28	0.001
12 m	89.63 ± 10.55	0.003	92.71 ± 7.41	0.019	78.06 ± 20.42	0.002	73.57 ± 24.28	0.002
18 m	88.10 ± 13.78	0.057	94.80 ± 6.91	0.065	74.48 ± 19.12	0.015	76.00 ± 25.84	0.022
24 m	92.26 ± 10.41	0.013	95.60 ± 5.13	0.057	85.63 ± 14.76	0.013	80.80 ± 24.41	0.021

Note: The significant improvement of activities of daily living (ADL) and sports subscale were seen at 3 months postoperatively ($p < 0.05$), while global function rating scale for ADL and sports was achieved at 6 months ($p < 0.05$).

outcomes confirmed the benefit of thin suprafascial free flap for coverage of foot and ankle defects.

Conclusion

The thin suprafascial free flap is a reliable and valuable reconstructive technique for foot and ankle reconstruction. The functional outcomes using the SWMT and FAAM tools showed statistically significant improvement within a short period of time after surgery. Therefore, this flap modification technique might be considered a reconstructive technique of choice to achieve goals of foot and ankle reconstruction.

Funding
None.

Conflict of Interest
None declared.

Acknowledgements
The authors gratefully acknowledge the patients who participated in this study, and for assistance with statistical analysis.

References

1 Schusterman MA, Miller MJ, Reece GP, Kroll SS, Marchi M, Goepfert H. A single center's experience with 308 free flaps for repair of head and neck cancer defects. Plast Reconstr Surg 1994; 93(03):472–478, discussion 479–480
2 Percival NJ, Sykes PJ, Earley MJ. Free flap surgery: the Welsh Regional Unit experience. Br J Plast Surg 1989;42(04):435–440
3 Kruavit A, Visuthikosol V, Srimuninnimit V, Punyahotra N. 10-year-free flaps at Ramathibodi Hospital. Journal of the International College of Surgeons of Thailand. 1998;41:45–59
4 Irons GB, Wood MB, Schmitt EH III. Experience with one hundred consecutive free flaps. Ann Plast Surg 1987;18(01):17–23
5 Harashina T. Analysis of 200 free flaps. Br J Plast Surg 1988;41 (01):33–36
6 Wettstein R, Schürch R, Banic A, Erni D, Harder Y. Review of 197 consecutive free flap reconstructions in the lower extremity. J Plast Reconstr Aesthet Surg 2008;61(07):772–776
7 Urken ML, Buchbinder D, Costantino PD, et al. Oromandibular reconstruction using microvascular composite flaps: report of 210 cases. Arch Otolaryngol Head Neck Surg 1998;124(01):46–55
8 Suh JD, Sercarz JA, Abemayor E, et al. Analysis of outcome and complications in 400 cases of microvascular head and neck reconstruction. Arch Otolaryngol Head Neck Surg 2004;130 (08):962–966
9 Shpitzer T, Neligan PC, Gullane PJ, et al. Oromandibular reconstruction with the fibular free flap. Analysis of 50 consecutive flaps. Arch Otolaryngol Head Neck Surg 1997;123(09):939–944

10 Pohlenz P, Blessmann M, Blake F, Li L, Schmelzle R, Heiland M. Outcome and complications of 540 microvascular free flaps: the Hamburg experience. Clin Oral Investig 2007;11(01):89–92
11 Nakatsuka T, Harii K, Asato H, et al. Analytic review of 2372 free flap transfers for head and neck reconstruction following cancer resection. J Reconstr Microsurg 2003;19(06):363–368, discussion 369
12 Kelly JL, Eadie PA, Orr D, Al-Rawi M, O'Donnell M, Lawlor D. Prospective evaluation of outcome measures in free-flap surgery. J Reconstr Microsurg 2004;20(06):435–438, discussion 439
13 Hamdi M, Weiler-Mithoff EM, Webster MH. Deep inferior epigastric perforator flap in breast reconstruction: experience with the first 50 flaps. Plast Reconstr Surg 1999;103(01):86–95
14 Eckardt A, Meyer A, Laas U, Hausamen JE. Reconstruction of defects in the head and neck with free flaps: 20 years experience. Br J Oral Maxillofac Surg 2007;45(01):11–15
15 Cordeiro PG, Disa JJ, Hidalgo DA, Hu QY. Reconstruction of the mandible with osseous free flaps: a 10-year experience with 150 consecutive patients. Plast Reconstr Surg 1999;104(05):1314–1320
16 Classen DA, Ward H. Complications in a consecutive series of 250 free flap operations. Ann Plast Surg 2006;56(05):557–561
17 Acosta R, Smit JM, Audolfsson T, et al. A clinical review of 9 years of free perforator flap breast reconstructions: an analysis of 675 flaps and the influence of new techniques on clinical practice. J Reconstr Microsurg 2011;27(02):91–98
18 Rodriguez ED, Bluebond-Langner R, Copeland C, Grim TN, Singh NK, Scalea T. Functional outcomes of posttraumatic lower limb salvage: a pilot study of anterolateral thigh perforator flaps versus muscle flaps. J Trauma 2009;66(05):1311–1314
19 Hong JP, Shin HW, Kim JJ, Wei FC, Chung YK. The use of anterolateral thigh perforator flaps in chronic osteomyelitis of the lower extremity. Plast Reconstr Surg 2005;115(01):142–147
20 Hallock GG. A paradigm shift in flap selection protocols for zones of the lower extremity using perforator flaps. J Reconstr Microsurg 2013;29(04):233–240
21 Akaranuchat N. Lower extremity reconstruction with vascularized free-tissue transfer: 20 years of experience in the Faculty of Medicine Siriraj Hospital, Mahidol University, Bangkok, Thailand. Siriraj Medical Journal. 2021;73(07):462–470
22 Narushima M, Yamasoba T, Iida T, et al. Pure skin perforator flaps: the anatomical vascularity of the super-thin flap. Plast Reconstr Surg 2018;142(03):351e–360e
23 Hong JP, Chung IW. The superficial fascia as a new plane of elevation for anterolateral thigh flaps. Ann Plast Surg 2013;70 (02):192–195
24 Jerosch-Herold C. Assessment of sensibility after nerve injury and repair: a systematic review of evidence for validity, reliability and responsiveness of tests. J Hand Surg [Br] 2005;30(03):252–264
25 Carrer P, Trevisan C, Curreri C, et al. Semmes-Weinstein monofilament examination for predicting physical performance and the risk of falls in older people: results of the Pro.V.A. longitudinal study. Arch Phys Med Rehabil 2018;99(01):137–143.e1
26 Martin RL, Irrgang JJ, Burdett RG, Conti SF, Van Swearingen JM. Evidence of validity for the Foot and Ankle Ability Measure (FAAM). Foot Ankle Int 2005;26(11):968–983
27 Arunakul M, Arunakul P, Suesiritumrong C, Angthong C, Chernchujit B. Validity and reliability of Thai version of the foot and ankle ability measure (FAAM) subjective form. J Med Assoc Thai 2015;98(06):561–567
28 Wei FC, Jain V, Celik N, Chen HC, Chuang DC, Lin CH. Have we found an ideal soft-tissue flap? An experience with 672 anterolateral thigh flaps. Plast Reconstr Surg 2002;109(07):2219–2226, discussion 2227–2230
29 Diamond S, Seth AK, Chattha AS, Iorio ML. Outcomes of subfascial, suprafascial, and super-thin anterolateral thigh flaps: tailoring thickness without added morbidity. J Reconstr Microsurg 2018; 34(03):176–184
30 Seth AK, Iorio ML. Super-thin and suprafascial anterolateral thigh perforator flaps for extremity reconstruction. J Reconstr Microsurg 2017;33(07):466–473
31 Thiele JR, Weiß J, Braig D, Zeller J, Stark GB, Eisenhardt SU. Evaluation of the suprafascial thin ALT flap in foot and ankle reconstruction. J Reconstr Microsurg 2022;38(02):151–159