

The Importance Of Long-term Follow-up In Patients Who Require Vascular Intervention Before Free Tissue Transfer

Rachel N. Rohrich, BS¹; Ryan P. Lin, MD¹; Sabrina F. Deleonibus, MS²; Kishan Shah, BS²; Meghan E. Currin, BA²; Jie J. Shih, MS²; Richard C. Youn, MD¹; Christopher E. Attinger, MD¹; Cameron M. Akbari, MD¹; Karen K. Evans, MD²

¹Department of Plastic and Reconstructive Surgery, MedStar Georgetown University Hospital, Washington, DC, USA ; ² Georgetown University School of Medicine, Washington, DC, USA ; ³Department of Vascular Surgery, MedStar Georgetown University Hospital, Washington DC, USA

Introduction

- Lower extremity (LE) microsurgical reconstruction in patients with peripheral arterial disease (PAD) is complex due to poor perfusion, infection, and co-existing comorbidities affecting distal flow
- Free tissue transfer (FTT) is effective for limb salvage, but has higher failure risk in the LE due to vascular disease; flap success depends on adequate perfusion which often requiring vascular imaging and intervention
- The current literature acknowledges the importance of vascular intervention before LE FTT, yet there is a lack of discussion regarding **postoperative management in these complex patients** and **factors that precipitate postoperative revascularization**

Objective

To characterize the population requiring postoperative revascularization after LE FTT, demonstrate the importance of long-term follow-up in this population, and guide efforts to enhance surveillance in this high-risk group.

Methods

- Retrospective review of all LE FTT cases (July 2011– July 2024) of 329 patients (356 FTTs)
- Groups: **Postoperative Revascularization** group (required a postoperative vascular intervention) *versus* **No Postoperative Revascularization** group
- To identify independent factors associated with requiring postoperative revascularization, univariate linear regression was performed on all variables with subsequent multivariate modeling

Results

During the study period, 356 LE FTT were performed in 346 patients with an immediate flap success rate of 96.1% and limb salvage rate of 87.1% over a follow-up period of 25.7 ± 27.2 months
30 (8.4%) cases required postoperative revascularization and the remaining 326 (91.6%) did not

Patient Characteristics

	Total	No Postoperative Revascularization	Required Postoperative Revascularization	P-Value
	No. (%)	No. (%)	No. (%)	
	356 (100.0)	326 (91.6)	30 (8.4)	
Patient Demographics				
Age, years (median [IQR])	58 [66-49]	57 [66-48]	59 [67-54]	0.348
Sex				0.318
Male	257 (72.2)	233 (71.5)	24 (80.0)	
Female	99 (27.8)	93 (28.5)	6 (20.0)	
BMI, kg/m ² (median [IQR])	28.8 [33.3-25.2]	28.7 [33.3-25.1]	29.5 [32.6-27.1]	0.544
Hospital LOS, days (median [IQR])	26.5 [36-20]	26 [36-20]	28.5 [36-23]	0.185
Postoperative LOS, days (median [IQR])	14 [19.5-11]	14 [9]	14 [8.5]	0.053
Comorbidities				
Smoking				0.313
Never smoker	221 (62.3)	206 (63.4)	15 (50.0)	
Former	87 (24.5)	78 (24.0)	9 (30.0)	
Current	47 (13.2)	41 (12.6)	6 (20.0)	
CCI (median [IQR])	4 [3]	4 [3]	5 [1]	<0.001*
Diabetes	198 (55.6)	169 (51.8)	29 (96.7)	<0.001*
History of PAD Diagnosis before angiography	124 (34.8)	101 (31.0)	23 (76.7)	<0.001*
PAD Diagnosis after Angiography	193 (54.2)	164 (50.3)	29 (96.7)	<0.001*
New PAD Diagnosis on Preop Angio	69 (19.4)	63 (19.3)	6 (20.0)	0.929
ESRD	19 (5.3)	15 (4.6)	4 (13.3)	0.042*
Hx of MI	57 (16.0)	55 (16.9)	2 (6.7)	0.195
CVA/TIA	16 (4.5)	14 (4.3)	2 (6.7)	0.635
CKD	40 (11.2)	32 (9.8)	8 (26.7)	0.005*
CHF	24 (6.7)	22 (6.8)	2 (6.7)	0.986
Home regimen at time of presentation				
Chronic steroid use	18 (5.1)	16 (4.9)	2 (6.7)	0.656
Use of AC or IVC	31 (8.7)	30 (9.2)	1 (3.3)	0.496
Home AP	147 (41.3)	126 (38.7)	21 (70.0)	0.001*
Preoperative Lab Values				
WBC (median [IQR])	7.5 [3.4]	7.4 [3.3]	9.2 [3.6]	0.004*
ESR (median [IQR])	60.5 (65.0)	55.0 (65.0)	90.0 (49.0)	0.003*
CRP (median [IQR])	18.0 (36.9)	17.0 (36.3)	24.5 (44.4)	0.273
A1C (median [IQR])	6.3 [2.4]	6.2 [2.2]	7.4 [2.9]	0.002*
Albumin (median [IQR])	3.2 [0.9]	3.2 [0.9]	2.8 [1.0]	0.164
Prealbumin (mean ± SD)	18.9 ± 7.0	19.3 ± 6.9	15.7 ± 7.0	0.014*
Hgb (median [IQR])	9.6 [2.4]	9.7 [2.4]	9.15 [1.9]	0.034*
Platelet Count (median [IQR])	273.5 [124.0]	267.5 [119.5]	332.0 [139.0]	0.004*
Thrombocytosis	75 [21.1]	61 (18.7)	14 (46.7)	<0.001*
*Bold-face values indicate statistical significance, p < 0.05.				
Abbreviations: PEI, percutaneous endovascular intervention; IQR, interquartile range; BMI, body mass index; LOS, length of stay; SD, standard deviation; CCI, Charlson Comorbidity Index; PAD, peripheral arterial disease; ESRD, end-stage renal disease; VTE, venous thromboembolism; Hx, history; MI, myocardial infarction; CVA, cerebrovascular accident; TIA, transient ischemic attack; CKD, chronic kidney disease; CHF, congestive heart failure; COPD, chronic obstructive pulmonary disease; AC, anticoagulant; IVC, inferior vena cava filter; AP, antiplatelet; WBC, white blood cell count; ESR, erythrocyte sedimentation rate; CRP, C-reactive protein; Hgb, hemoglobin.				

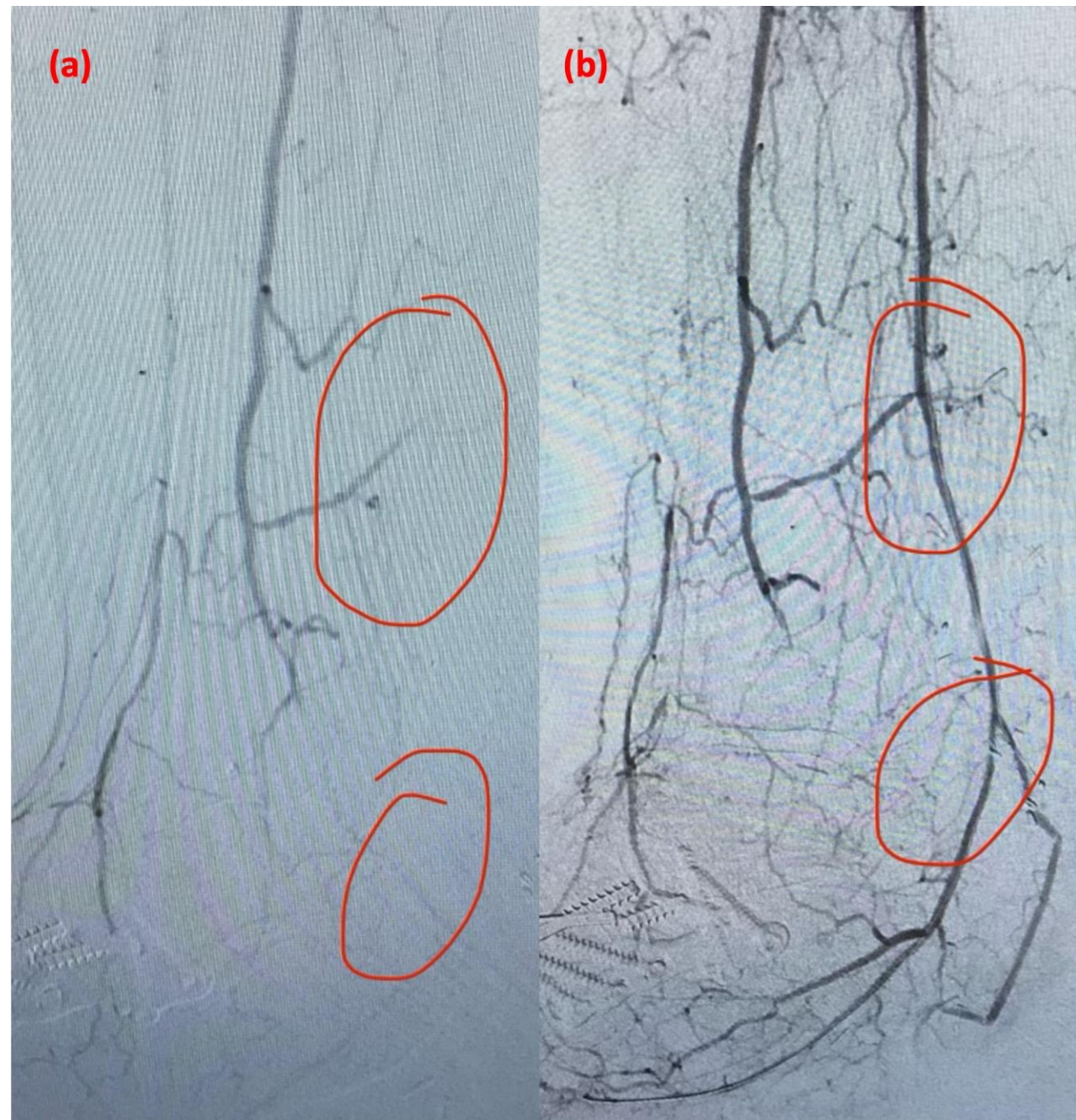
Multivariate Model for Requiring Postoperative Vascular Intervention

Variable	Odds Ratio (95% CI)	P-value
Diabetes	3.89 (0.40–37.54)	0.24
CCI	1.09 (0.82–1.44)	0.549
PVD VRO	4.18 (0.47–37.02)	0.199
Neuropathy	1.17 (0.40–3.48)	0.774
CKD	1.35 (0.39–4.61)	0.635
Preoperative Intervention	6.45 (2.32–17.92)	<0.001*
Intraop Thrombosis	10.22 (0.67–156.38)	0.095
Intraop Revision	1.81 (0.38–8.66)	0.459
Calcified Vessels	1.76 (0.65–4.74)	0.265
Partial Flap Loss	1.70 (0.39–7.38)	0.476
Infection	1.63 (0.55–4.84)	0.383
Recurrent Lesion	1.30 (0.48–3.54)	0.605
New Lesion	2.18 (0.79–6.05)	0.133

- Most of the population was male (72.2%)
- Median age of 58 (IQR: 17) and BMI of 28.8 (IQR: 8.1) kg/m².
- The median hospital stay was 26.5 (IQR: 16) days.

Patients that required postoperative revascularization represented a significantly **more comorbid cohort**, with a significantly higher:

- Median CCI (5, IQR: 1 vs. 4, IQR: 3; p<0.001)
- Rate of **diabetes** (96.7% vs. 51.8%, p<0.001)
- Rate of **peripheral arterial disease** (96.7% vs. 50.3%, p<0.001)
- Rate of **chronic kidney disease** (26.7% vs. 9.8%, p=0.005)
- Rate of **end-stage renal disease** (13.3% vs. 4.4%, p=0.042).
- This group also demonstrated significantly more **disadvantaged laboratory results** in terms of WBC (p=0.004), ESR (p=0.003), hemoglobin A1C (p=0.002), prealbumin (p=0.014), hemoglobin (p=0.034), and platelet count (p=0.004) values.

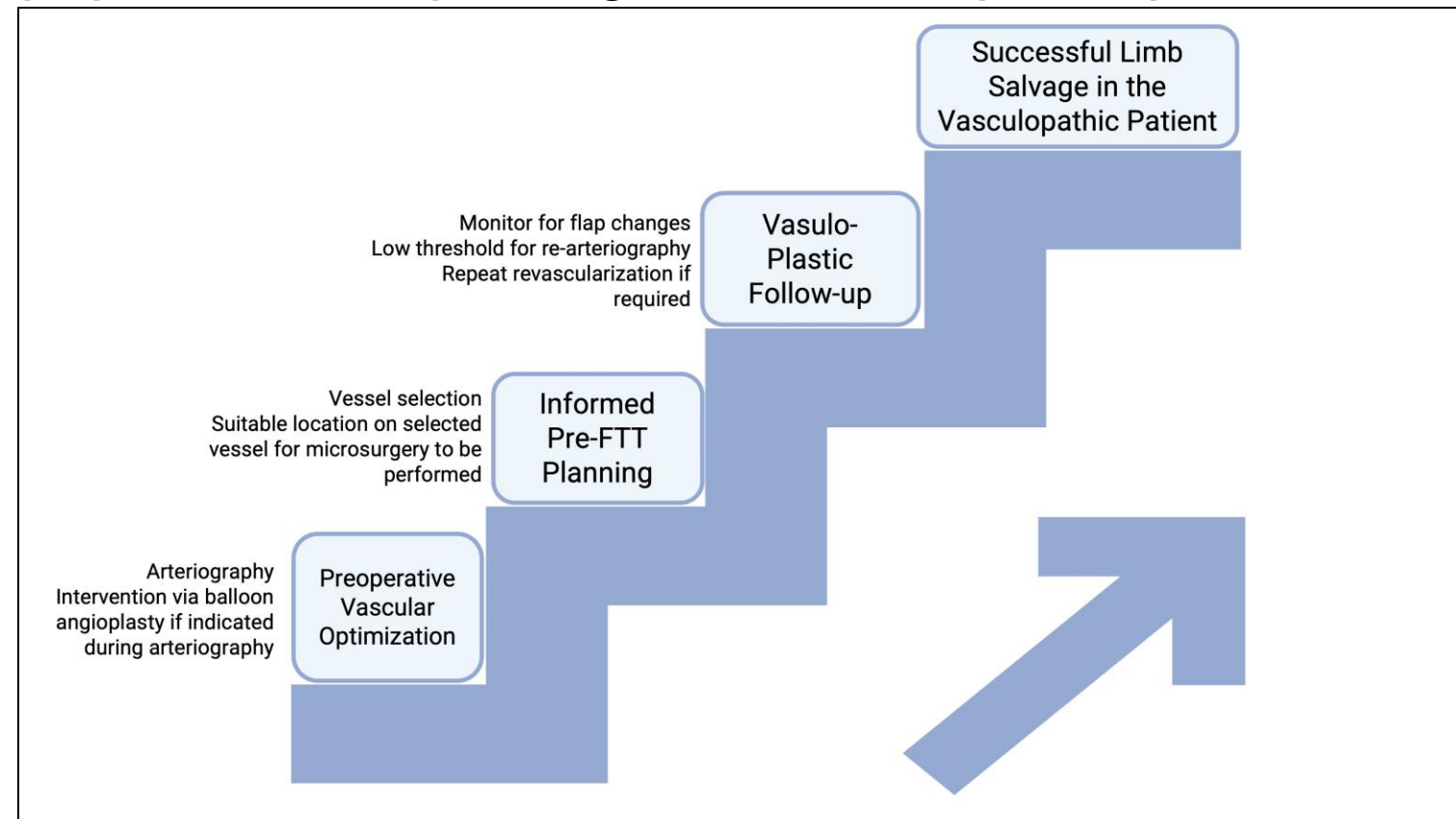


(Above) **Representative Case of Postoperative Monitoring of Flap Anastomosis in Patients Who Required Preoperative Angioplasty.**

Postoperatively, this flap became progressively ischemic, leading to clinical suspicion of compromise of the original angioplasty site performed on the flap's recipient vessel (posterior tibial artery, PT). **(A)** Angiography was subsequently performed, demonstrating that the PT angioplasty had re-stenosed and there was no visualized inflow through the site of anastomosis into the flap. **(B)** A vascular intervention was therefore performed at the site of stenosis, which restored inflow and allowed for visualization of a patent vascular anastomosis to the free flap. Signs of flap ischemia subsequently resolved.

Discussion

- Patients with extensive comorbidities affecting LE vasculature and that require preoperative vascular optimized before LE FTT **must be monitored longitudinally by a team of both vascular and plastic surgeons (6.5x risk)**.
- In taking a **vasculo-plastic approach** with long-term surveillance, durable limb salvage is possible in this population despite high rates of flap complication:.



- We hope that these results encourage similar teams to fight for long-term follow-up in this challenging patient population prone to vascular complications after microsurgical FTT.
- Findings challenge the view that ischemic patients are poor FTT candidates; however, endorse close postoperative monitoring for vascular complication.

Conclusion

While there are a number of factors contributing to the need for postoperative vascular intervention, the need for preoperative vascular intervention is the most powerful clinical indicator of this event. Management of the patients requires long-term surveillance with both plastic and vascular surgery.

References

1. Li KR, Liew CC, Neugebauer MB, et al. A Multidisciplinary Approach to End-Stage Limb Salvage in the Highly Comorbid Atrial Atrial Population. J Clin Med. 2024;13(8):2406.
2. Wernick B, Nakhassak P, Stawicki SP. Impaired wound healing. 2018.
3. Gooden MA, Gentile AT, Mills JL, et al. Free tissue transfer to extend the limits of limb salvage for lower extremity tissue loss. Am J Surg. 1997;174(6):644-649.
4. Janshofer DE, Lakhani C, Kim PJ, et al. Utility of preoperative arteriography in chronic LE wounds. Plast Reconstr Surg. 2019;143(2):604-613.
5. Rosenthal E, Carroll W, Doche M, et al. Stenting the head and neck microvascular reconstruction. Head Neck. 2004;26(1):559-569.
6. Mehanna BJ, Santoro TD, Arcila E, et al. Complications after microvascular breast reconstruction. Plast Reconstr Surg. 2006;118(5):1100-1109.
7. Massoni H, Clark EG, Puyat KC, et al. Predictive risk factors of free flap thrombosis. Microsurgery. 2014;36(8):588-594.
8. Cho EH, Garcia RM, Pen I, et al. Vascular considerations in LE FTT: 231 cases. Microsurgery. 2016;36(4):276-283.
9. Bantner MP, Wilson S, Lewis H, et al. Microvascular free tissue transfer in lower limb. J Plast Reconstr Aesthet Surg. 2008;61(5):625-628.
10. Nigam M, Zolper EG, Sharif-Akary B, et al. Expanding criteria for limb salvage. Plast Reconstr Surg. 2022;150(1):197-209.
11. Cho C, Kuo P-J, Chen Y-C, et al. Vascular intervention + FTT for diabetic limb salvage. Ann Plast Surg. 2016;77(Suppl 1):S16-S21.
12. Huang C-C, Chang C-H, Hsu H, et al. Endovascular revascularization + FTT. J Plast Reconstr Aesthet Surg. 2014;27(10):1407-1414.
13. Jiang Y-J, Peik MC, Hong YS, et al. LE salvage post-angioplasty + FTT. J Plast Reconstr Aesthet Surg. 2014;67(8):1136-1143.
14. Ishikawa S, Arai K, Kurihara T, et al. Endovascular therapy + free flap in CL. J Plast Surg Hand Surg. 2023;37(1):49-62-69.
15. Charlson ME, Pompei P, Ales KL, MacKenzie CR. Charlson Comorbidity Index. J Chronic Dis. 1987;40(5):373-383.
16. Li KR, Hoffman SH, Gupta NJ, et al. Refining a multidisciplinary "vasculo-plastic" approach. Plast Reconstr Surg. 2024.
17. Delder R, Gupta NJ, Bowl JD, et al. Risk-stratified anticoagulation improves FTT. Plast Reconstr Surg. 2023;152(3):653-666.