

## Ultrasound – Deep Vein Arterialization Post-Op Graft Surveillance

### **PURPOSE:**

To survey the deep vein arterialization graft including arterial inflow and venous outflow for continued viability and “stealing branches” of the arterialized vein.

### **SCOPE:**

Applies to Ultrasound deep vein arterialization graft evaluation requested to be performed as part of routine post-operative follow-up and surveillance:

- UT Southwestern William P. Clements Jr. University Hospital and Clinics, Imaging Services (UTSW Radiology)

### **ORDERABLE:**

- US ARTERIAL GRAFTS EXTREM LOWER UNILAT

### **CHARGEABLE:**

- 93926 (Unilateral Lower Extremity Arterial Duplex)

### **INDICATIONS:**

- Post-operative surveillance of the deep vein arterialization graft and outflow vasculature.
- May be referred to as DVA or LimFlow Graft

### **CONTRAINDICATIONS:**

- No absolute contraindications
- Evaluation of graft may not be possible within the first 24-48 hours post-op due to post-surgical air and limited visibility of graft. If surgeon requests evaluation during this time period, evaluate what you can see.

### **EQUIPMENT:**

- Commercial duplex Doppler ultrasound system
  - Preferably a linear array transducer that allows for appropriate resolution of anatomy (frequency range of 9 MHz or greater), capable of duplex imaging. Sector or curvilinear transducers may be required for appropriate penetration in patients with edema or large body habitus
  - A hockey stick probe may be used for plantar vein evaluation

### **PATIENT PREPARATION:**

- Patient should be placed in a supine position.

### **EXAMINATION:**

#### **GENERAL GUIDELINES:**

- The duplex examination will be unilateral unless otherwise indicated.
- A complete examination includes evaluation of the entire course of the accessible portions of each vessel and graft.
- Variations in technique must be documented.

**EXAM INITIATION:**

- Introduce yourself to the patient/family.
- Verify patient identity using patient name and DOB.
- Explain test.
- Obtain patient history including symptoms.
- Enter and store data page.
- Patient should be placed in a supine position.

**TECHNICAL CONSIDERATIONS:**

- Equipment gain and display settings will be optimized while imaging vessels with respect to depth, dynamic range, and focal zones.
- Proximal and distal refer to the relative distance from the attached end of the limb (proximal PTV/PTA is closer to knee, and distal is closer to foot; Prox GSV is below knee, distal GSV is at ankle).
- **TADV Graft Considerations**
  - Graft will be labeled “TADV Graft” (Transcatheter arterialization of deep veins).
  - Flow volumes will be obtained at multiple levels.
  - Do not obtain a volume flow at a stenosis. Instead, obtain pre-, at-, and post- stenosis PSV and EDV.
  - Any flow volume < 75 ml/min needs surgical attention!
  - Any flow volume > 400 ml/min suggests there may be stealing branches. Evaluate carefully!
    - If a stealing branch is suspected, evaluate flow volume prox and distal to branch. If there is a >100 ml/min from prox to distal, this is a functional stealing branch.

**DOCUMENTATION:**

**1. TADV Graft Evaluation**

1.	TADV Crossing Stent	Long, with and without color
2.	TADV Crossing Stent	Long, spectral Doppler w/ PSV, EDV
3.	TADV Crossing Stent	Long, Flow Volume
4.	TADV Graft, PROX	Long, with and without color
5.	TADV Graft, PROX	Long, spectral Doppler w/ PSV, EDV
6.	TADV Graft, PROX	Long, Flow Volume
7.	TADV Graft, MID	Long, with and without color
8.	TADV Graft, MID	Long, spectral Doppler w/ PSV, EDV
9.	TADV Graft, MID	Long, Flow Volume
10.	TADV Graft, DIST edge of stent	Long, with and without color
11.	TADV Graft, DIST edge of stent	Long, spectral Doppler w/ PSV, EDV
12.	TADV Graft, DIST edge of stent	Long, Flow Volume
13.	Outflow in Arterialized vein, 2 cm below TADV Graft	Long, with and without color
14.	Outflow in Arterialized vein, 2 cm below TADV Graft	Long, spectral Doppler w/ PSV, EDV
15.	Outflow in Arterialized vein, 2 cm below TADV Graft	Long, Flow Volume
16.	Lateral Plantar Vein (LPV), PROX	Long, with and without color
17.	Lateral Plantar Vein (LPV), PROX	Long, spectral Doppler w/ PSV, EDV
18.	Lateral Plantar Vein (LPV), PROX	Long, Flow Volume
19.	Lateral Plantar Vein (LPV), DIST	Long, with and without color
20.	Lateral Plantar Vein (LPV), DIST	Long, spectral Doppler w/ PSV, EDV
21.	Lateral Plantar Vein (LPV), DIST	Long, Flow Volume
<p><b>*Evaluate for any LPV branches from the stent end at the prox foot to distal foot. If visualized, obtain VF Proximal to and Distal to the branch</b></p> <p><b>**Evaluate for any stenosis within the stent and in the outflow pedal vein</b></p>		

- If you identify a stenosis (obvious narrowing on grayscale, PSV > 180 cm/sec, focal spectral broadening/turbulent flow), you will need to document the following:
  - At the site of stenosis
    - Grayscale lumen diameter
    - Doppler waveform
    - Peak Systolic Velocity (PSV)
  - At a site 2 cm proximal to the stenosis (or relatively normal segment of proximal vessel)
    - Grayscale diameter
    - Doppler waveform
    - PSV
- Save data page(s)

#### **PROCESSING:**

- Review examination data
- Export all images to PACS
- Note any study limitations

#### **REFERENCES:**

- Shishehbor MH, Powell RJ, Montero-Baker MF, et al. Transcatheter Arterialization of Deep Veins in Chronic Limb-Threatening Ischemia. *New England Journal of Medicine*. 2023;388(13):1171-1180. doi:<https://doi.org/10.1056/nejmoa2212754>
- N'Dandu Z, Bonilla J, Yousef GM, White CJ. Percutaneous deep vein arterialization: An emerging technique for no-option chronic limb-threatening ischemia patients. *Catheterization and Cardiovascular Interventions*. 2020;97(4):685-690. doi:<https://doi.org/10.1002/ccd.29386>
- Ho VT, Gologorsky R, Kibrik P, et al. Open, percutaneous, and hybrid deep venous arterialization technique for no-option foot salvage. *Journal of Vascular Surgery*. 2020;71(6):2152-2160. doi:<https://doi.org/10.1016/j.jvs.2019.10.085>
- Yan Q, Treffalls JA, Ferrer L, Davies MG. A Review of Current Noninvasive Imaging Surveillance Practices for Deep Venous Arterialization Procedures. *Journal for Vascular Ultrasound*. 2021;45(2):59-63. doi:<https://doi.org/10.1177/1544316721996944>
- Fitzpatrick S, Dunlap E, Nagarsheth KH. Utilization of Deep Vein Arterialization for Limb Salvage. *Journal for Vascular Ultrasound*. Published online October 6, 2023. doi:<https://doi.org/10.1177/15443167231202502>
- Clair DG, Mustapha JA, Shishehbor MH, et al. PROMISE I early feasibility study of the LimFlow System for percutaneous deep vein arterialization in no-option chronic limb-threatening ischemia 12-month results. *Journal of Vascular Surgery*. Published online May 18, 2021. doi:<https://doi.org/10.1016/j.jvs.2021.04.057>

**DIAGNOSTIC CRITERIA:**

- Ideal VF range is 100-300 ml/min

**Table 15** Diagnostic criteria for peripheral arterial diameter reduction

	Diameter reduction	Waveform	Spectral broadening	PSV distal/PSV proximal
Normal	0	Triphasic	Absent	+++ No change
Mild	1%-19%	Triphasic	Present	< 2:1
Moderate	20%-49%	Biphasic	Present	< 2:1
Severe	50%-99%	Monophasic	Present	> 2:1*

*PSV, Peak systolic velocity.*  
 \*>4:1 Suggests >75% stenosis, >7:1 suggests > 90% stenosis.

**Table 17** Diagnostic criteria for vein graft lesions using peak systolic velocity

- Minimal stenosis <20% with PSV ratio < 1.4 and < 125 cm/s
- Moderate stenosis of 20% to 50% with PSV ratio 1.5 to 2.4 and a PSV <180 cm/s
- Severe stenosis 50% to 75% with PSV ratio 2.5 to 4 and a PSV >180 cm/s
- High-grade stenosis > 75% with PSV ratio > 4 and PSV > 300 cm/s

*PSV, Peak systolic velocity.*

**Table 18** Interpretation criteria for arterial stenosis after percutaneous revascularization

- PSV >180 cm/s
- PSV ratios >2 indicate significant stenosis
- Changes in waveform shape and velocity measurements on serial examinations warrant close interval follow-up

*PSV, Peak systolic velocity.*

**APPENDIX:**

**Pedal Venous Anatomy: Overview**

**Plantar Veins**

**Bottom view of left foot**

**Lateral Plantar Vein**  
• Paired system

**VEINS TO KNOW**

1. Lateral Plantar
2. Medial Plantar
3. Posterior Tibial
4. Lateral Marginal
5. Dorsal Venous Arch
6. Medial Marginal
7. Greater Saphenous

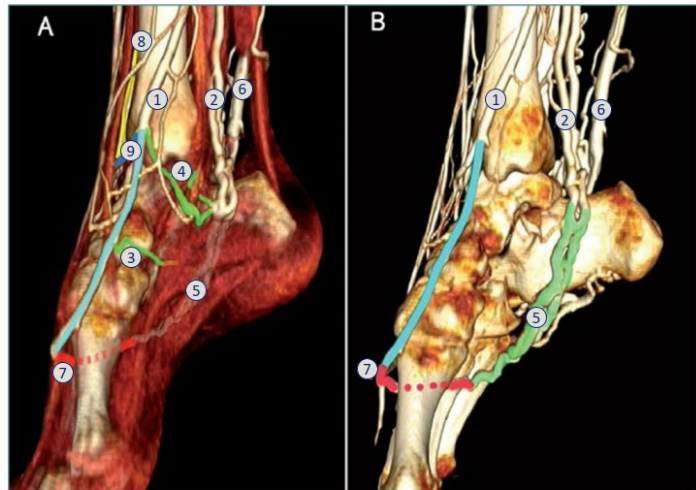
**Dorsal Veins**

**Top view of left foot**

LF-CA-TM-27 Rev 3
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**Pedal Venous Anatomy: Arterialized Circuit**

1. Great saphenous vein
2. Posterior tibial veins
3. Navicular perforator vein
4. Inframalleolar perforator vein
5. Lateral plantar veins
6. Small saphenous vein
7. Perforator vein of the first intermetatarsal space
8. Anterior tibial vein
9. Dorsal perforator to the anterior tibial vein



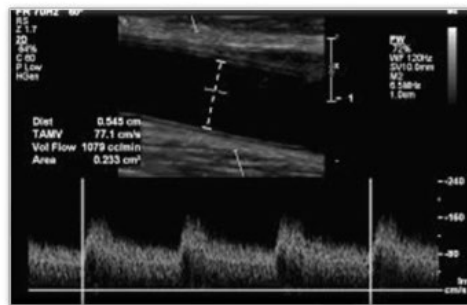
Uhl JF, Vuolo M, Gillot, C. Anatomy of foot and ankle perforator veins. Phlebology. 2017;24(2):105-112.

# Volume Flow Rate: **Correct Example**

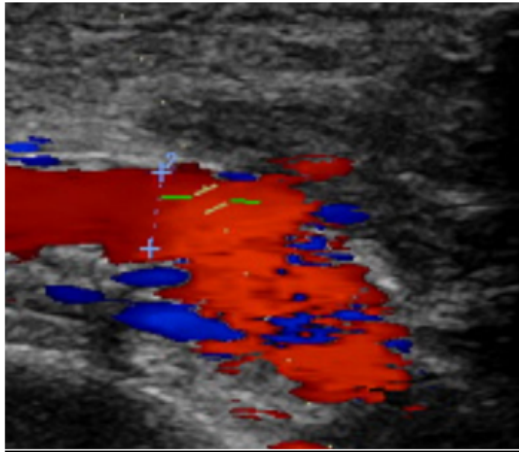
**Proper technique is critical**



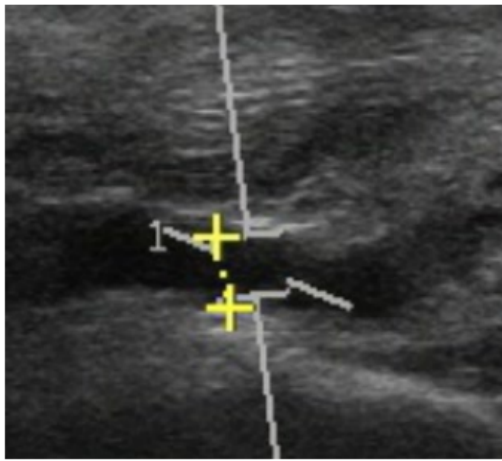
TAMV averaged over several cardiac cycles



**Incorrect Examples:**



- Why:**
1. Sample gate is not wide enough for the entire vessel.
  2. Doppler sample not centered in the vessel.
  3. AP measurement is not accurate/perpendicular to the angle.
  4. AP measurement is not taken at the same spot the Doppler is.



- Why:**
1. Sample gate is too small.
  2. AP measurement is not a true AP measurement / obliqued.
  3. Doppler angle is not parallel to the vessel wall.

**CHANGE HISTORY:**

STATUS	NAME & TITLE	DATE	BRIEF SUMMARY
Submission	Skye Smola, US Technical Supervisor	11/27/2023	Submitted
Approval	Dr. Girish Kumar	12/22/2023	Approved
Review			Reviewed
Revisions	Dr. David Fetzer, Skye Smola, Kim Pong	2/5/24	In Review 2/20/24