Ultrasound – Deep Vein Arterialization Pre-Op Evaluation

PURPOSE:
To evaluate calf and pedal arteries and veins to determine viability for LimFlow procedure in patients with Critical Limb-Threatening Ischemia (CLTI).

SCOPE:
Applies to Ultrasound Lower Extremity Vein Mapping and TBI studies requested to be performed as part of planning for LimFlow procedure:

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

ORDERABLE:

- US VEIN MAPPING LOWER EXTREMITY PRE-SURGICAL
- US DOPPLER ARTERIAL LOWER EXTREMITY LEFT/RIGHT
- US ANKLE BRACHIAL ARTERIAL INDICES (ABI)

CHARGEABLE:

- 93971 (Unilateral Lower Extremity Vein Mapping)
- 93926 (Unilateral Lower Extremity Arterial Duplex)
- 93922 (ABI)
    - For unilateral evaluation due to amputation, Add “Rt” or “Lt” as a modifier in “Charges”.

INDICATIONS:

- Pre-operative screening and planning for deep vein arterialization procedure
- May be referred to as DVA or LimFlow Graft

CONTRAINDICATIONS:

- No absolute contraindications

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
- Vasculab physiologic testing system
    - 4-8 MHz continuous wave transducer

PATIENT PREPARATION:

- Patient should be placed in a supine reverse Trendelenburg position.
- Place a tourniquet at the patient’s ankle to maximize vein diameter in the foot.
- Leg and/or plantar surface of foot should be kept warm to prevent vein spasm (i.e. warm pack or warm blanket).

EXAMINATION:

GENERAL GUIDELINES:

- The examination will be unilateral unless otherwise indicated.
- A complete examination includes evaluation of the entire course of the accessible portions of each vessel.
- 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 reverse Trendelenburg 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 is at ankle).

- **Venous Considerations**
  - Apply a tourniquet at the ankle to maximize vein diameter.
  - All vessels will be checked for patency with intermittent transducer compression.
  - Document extent of thrombus, if identified.
  - Document areas of wall thickening, thrombus, or large varicosities, perforators, or branches off the LPV or GSV.
  - Entire length of calf veins (PTV, Pero V, GSV, ATV) should be evaluated with compressions for DVT.
  - In the absence of thrombus (PTV, Pero V, GSV, ATV), *only* 1 level (at distal) needs to be documented (Trans compression cine).
  - ATV is only evaluated in occlusion or absence of the GSV.

- **Arterial Considerations**
  - Only distal arteries at the ankle will be evaluated (ie. PTA, ATA, Pero A).
  - ATA is evaluated on all patients.
  - All velocities should be obtained at 60® and parallel to vessel walls.

- **TBI Considerations**
  - Bilateral TBI should be obtained.
  - Required on all patients unless patient has a TMA – trans metatarsal amputation.
  - If 1st digit is amputated, obtain next neighboring digit TBI. It is not required to obtain same digit bilaterally (I.e. If Rt 1st digit is amputated, obtain Rt 2nd digit and Lt 1st digit).

DOCUMENTATION:

1. **Venous Pre-Op DVT & Vein Mapping Evaluation**

1	Pop V Prox	Trans, Compression cine
2	Pop V Prox	Long, with & without color
3	Pop V Prox	Long, w/ spectral Doppler
4	PTV Distal	Trans, compression cine
5	Largest of paired PTV at ankle	Trans, grayscale – AP and Trans diameter
6	Largest of paired LPV at Prox foot	Trans, grayscale – AP and Trans diameter
7	Largest of paired LPV at mid/Distal foot	Trans, grayscale – AP and Trans diameter
8	Pero V Distal	Trans, Compression cine
9	GSV at ankle	Trans, Compression cine
10	MMV at prox dorsal foot	Trans, grayscale – AP and Trans diameter
11	MMV at mid dorsal foot	Trans, grayscale – AP and Trans diameter
12	MMV at distal dorsal foot	Trans, grayscale – AP and Trans diameter
***If GSV is occluded or absent, evaluate ATV's**		
13	ATV at ankle	Trans, Compression cine
14	Largest of paired ATV at ankle	Trans, grayscale – AP and Trans diameter

PTV: Posterior Tibial Vein
GSV: Greater Saphenous Vein
ATV: Anterior Tibial Vein
LPV: Lateral Plantar Vein
MMV: Medial Marginal Vein

2. **Arterial Evaluation**

1	PTA at ankle	Long, with and without color
2	PTA at ankle	Long, Spectral Doppler w/ PSV & EDV measurement
3	ATA at ankle	Long, with and without color
4	ATA at ankle	Long, Spectral Doppler w/ PSV & EDV measurement
5	Pero A at ankle	Long, with and without color
6	Pero A at ankle	Long, Spectral Doppler w/ PSV & EDV measurement

3. **TBI Evaluation (Toe-brachial Index)**
   Obtain bilateral TBI

- 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
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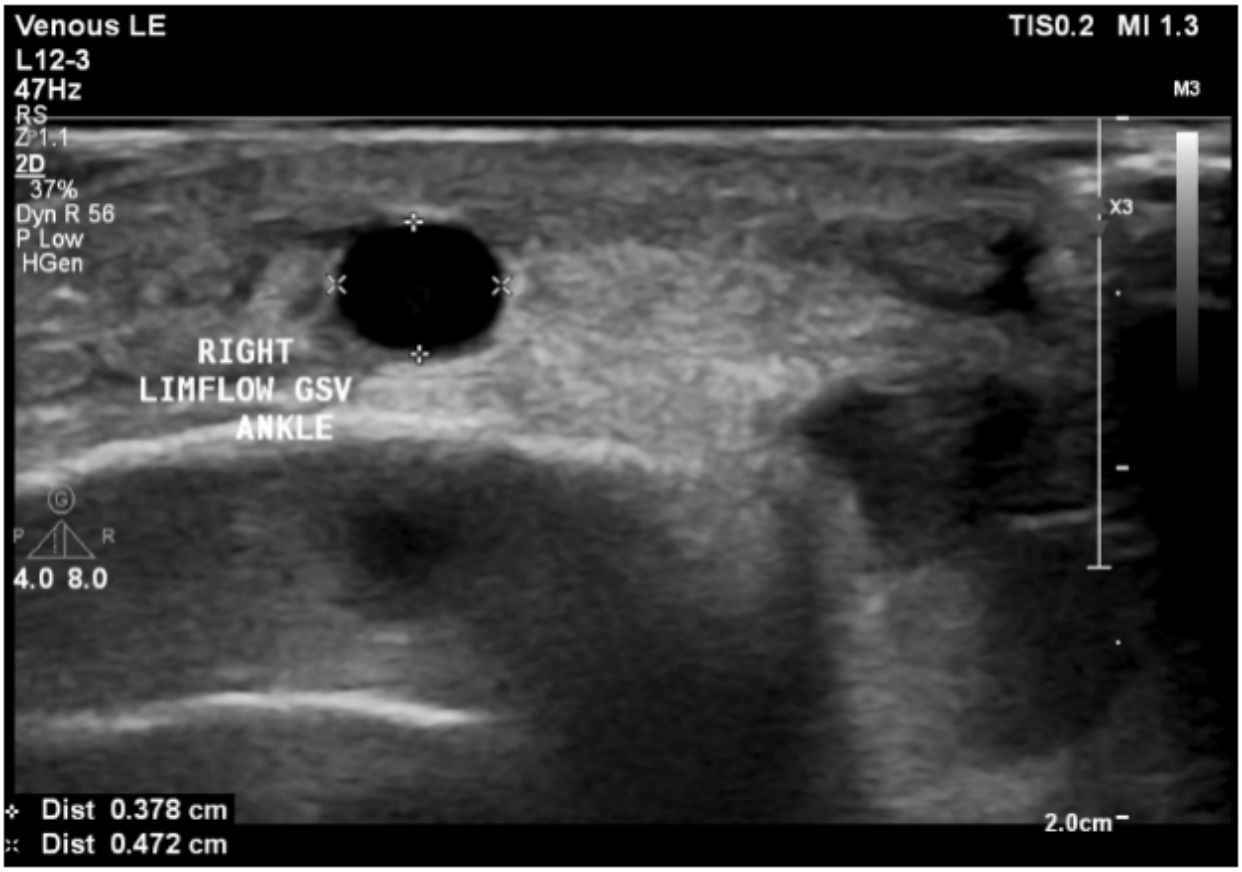
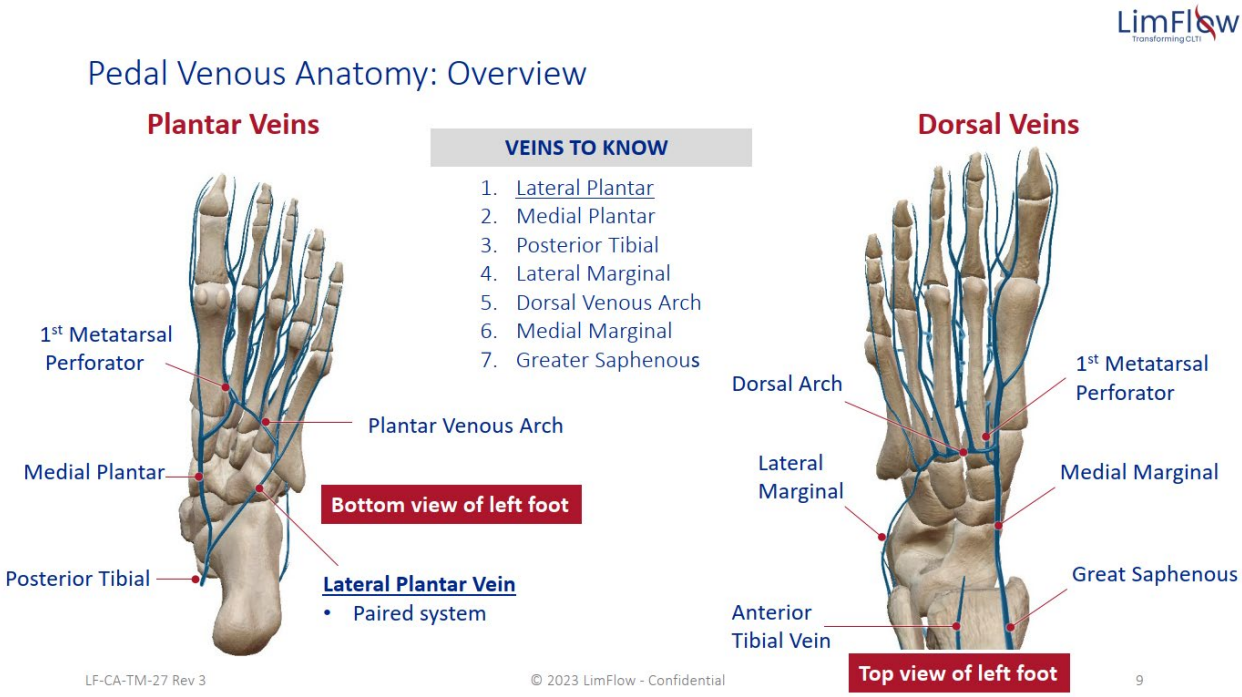
DIAGNOSTIC CRITERIA:

- Ideal LPV measurement: ≤ 3.0 mm

APPENDIX:


Venous LE
L12-3
47Hz
RS
Z 1.1
2D
37%
Dyn R 56
P Low
HGen
TIS0.2 MI 1.3
M3
X3
RIGHT
LIMFLOW GSV
ANKLE
4.0 8.0
Dist 0.378 cm
Dist 0.472 cm
2.0cm


LimFlow
Pedal Venous Anatomy: Overview
Plantar Veins
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
1st Metatarsal Perforator
Plantar Venous Arch
Medial Plantar
Bottom view of left foot
Posterior Tibial
Lateral Plantar Vein
• Paired system
Dorsal Veins
Dorsal Arch
1st Metatarsal Perforator
Lateral Marginal
Medial Marginal
Great Saphenous
Anterior Tibial Vein
Top view of left foot
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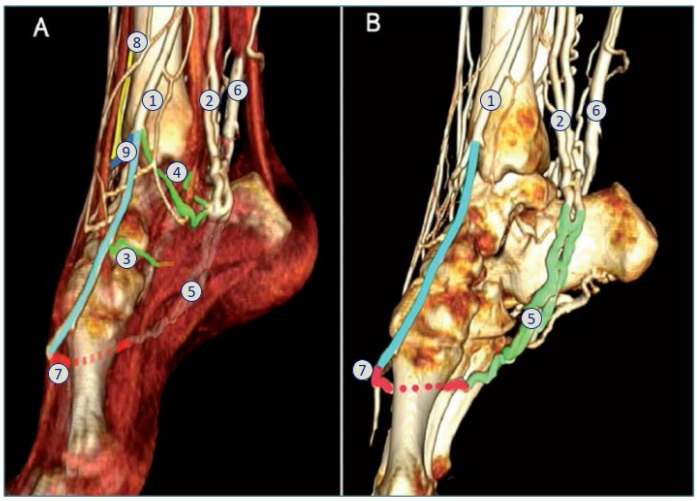
Pedal Venous Anatomy: Arterialized Circuit

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 inter-metatarsal 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. Phlebolymphology. 2017;24(2):105-112.

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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			