Ultrasound – Lower Extremity: Venous Insufficiency

PURPOSE:
To evaluate deep and superficial venous systems for evidence of valvular incompetence (venous reflux).

SCOPE:
- Applies to all Ultrasound Lower Extremity Venous Insufficiency studies performed in:
- UT Southwestern Zale-Lipshy University Hospital, William P. Clements Jr. University Hospital, and all University Hospital-based Clinics Imaging Services (UTSW)
- Parkland Health and Hospital System Department of Radiology (PHHS)

INDICATIONS:
- Venous ulcers
- Visible varicose veins
- Pre-op evaluation for venous insufficiency
- Feeling of heaviness in lower extremity
- Pain, edema, or discoloration

CONTRAINDICATIONS:
- Patients with bandages, casts
- Patients who are unable to stand for an extended length of time
- Uncooperative patients (eg. altered mental status, involuntary movement)
- Patients with severe edema (relative contraindication)
- Obese patients with deep vessels (relative contraindication)
- Open draining ulcers

EQUIPMENT:
- Commercial ultrasound device (eg. EPIQ 5G & 7G; Siemens Sequoia; GE E10) with duplex Doppler capability
- Linear transducer with a frequency range from 7-18 MHz
- Curved transducer with a frequency range from 1-9 MHz

PATIENT PREPARATION:
- In a standing position, the patient should stand facing the sonographer with the leg rotated slightly externally.
- The patient should place a majority of their weight on the contralateral leg.
- If the patient is unable to stand for an extended amount of time, lay the patient down in the reverse Trendelenberg position. The feet must be 15-20 degrees lower than the heart.

EXAMINATION:
GENERAL GUIDELINES:
- A complete examination includes evaluation of the entire course of the accessible portions of each vein
- A complete venous duplex reflux exam must include both B-mode imaging and Doppler spectral analysis
- Study may be unilateral or bilateral
- Variations in technique must be documented

EXAM INITIATION:

- Introduce yourself to the patient
- Verify patient identity using patient name and DOB
- Explain test
- Obtain patient history including symptoms.
- Enter and store data page.

TECHNICAL CONSIDERATIONS:

- The exam room should be warm to avoid vasoconstriction
- Equipment gain and display settings will be optimized while imaging vessels with respect to depth, dynamic range, and focal zones
- Color-flow Doppler images with proper color scale to demonstrate areas of high flow and color aliasing
- Spectral Doppler waveform assessment will be done in long axis and will be displayed below the baseline. Assess for spontaneity, phasicity, and augmentation
    - Transverse gray scale imaging will be performed with and without transducer compressions
    - The entire length of the veins will be evaluated.
- Venous compression:
    - Gentle compression may be applied to vessels filled with thrombus in order to confirm non-compressibility (excluding slow flow or other artifact). However, repeated or vigorous compression should be omitted in the presence of identifiable clot.
    - For suspected non-occlusive thrombus or equivocal intraluminal filling defects, compression should be attempted to document compressibility.
    - In the presence of short-segment thrombus, compression of veins distal (peripheral) to this clot may be attempted in equivocal cases. This allows for documenting the extent of the thrombus. Calf augmentation should be omitted distal/inferior to a defined clot.
- If there is no evidence of DVT, proceed with evaluation of venous insufficiency
- If DVT is identified, reading IR physician will be consulted before continuing with exam to advise on how to proceed
- Manual augmentation is applied inferior to the vessel interrogated for venous reflux
- Reflux time is measured from the start to end of the reversed flow. Abnormal reflux time for superficial veins is > 0.5 sec and for perforating veins is > 0.35 sec
- Perforating veins measuring > 3.5mm in diameter are considered abnormal, indicating incompetent perforating veins
- If a perforator is identified, evaluate for competence. Incompetent perforating veins will have bi-directional flow.
- If the perforator is incompetent, evaluate the deep vein connection
- Normal perforators do not need to be documented

DOCUMENTATION:

	DVT Evaluation	
1	CFV	Cine Compression
2	CFV	Long grayscale, color, and spectral with valsalva
3	SFJ	Cine Compression
4	Fem V Prox	Cine Compression
5	Fem V Mid	Cine Compression
6	Fem V Mid	Long grayscale, color, and spectral with valsalva
7	Fem V Dist	Cine Compression
8	Pop V Prox	Cine Compression
9	Pop V Prox	Long grayscale, color, spectral with distal augment
10	Pop V Dist with Tibioperoneal trunk	Cine Compression
11	PTV	Cine Compression
12	PTV	Long grayscale, color
13	Pero V	Cine Compression
14	Pero V	Long grayscale, color
	Reflux Evaluation	
1	GSV at SFJ	Trans AP Diameter
2	GSV at SFJ	Long spectral waveform with distal augment
3	Accessory GSV's (when seen)	Trans AP Diameter
4	Accessory GSV's (when seen)	Long spectral waveform with distal augment
5	GSV Prox Thigh	Trans AP Diameter
6	GSV Prox Thigh	Long spectral waveform with distal augment
7	GSV above Knee	Trans AP Diameter
8	GSV above Knee	Long spectral waveform with distal augment
9	GSV at Knee	Trans AP Diameter
10	GSV at Knee	Long spectral waveform with distal augment
11	GSV below Knee	Trans AP Diameter
12	GSV below Knee	Long spectral waveform with distal augment
13	SSV at SPJ	Trans AP Diameter
14	SSV at SPJ	Long spectral waveform with distal augment
15	SSV Mid	Trans AP Diameter
16	SSV Mid	Long spectral waveform with distal augment

Perforating Veins:

Incompetent perforating veins will have bi-directional flow. The deep vein connection should be evaluated if perforator incompetence is suspected. If evaluated, record perforating vein location, AP diameter, and spectral Doppler waveforms with augmentation as above. Normal perforators do not need to be evaluated.

PROCESSING:

- Review examination data
- Export all images to PACS
- Technologist will document in EPIC if patient is positive for DVT
- Note any study limitations

CHANGE HISTORY:

STATUS	NAME & TITLE	DATE	BRIEF SUMMARY
Submission	Mark Reddick, MD	**6/9/2016**	Submitted
Approval	David Fetzer, MD, Director	**6/20/2016**	Approved
Review	Eddie Hyatt	**12/15/2018**	Reviewed
Revisions	David Fetzer	**01/02/2019**	Updated diagnostic criteria
	Christine Chen	**08/12/2019**	Updated description; documentation requirements
	Ashten Burleson	**07/24/2023**	Updated diagnostic criteria; images of reflux

US Venous Insufficiency Diagnostic Criteria

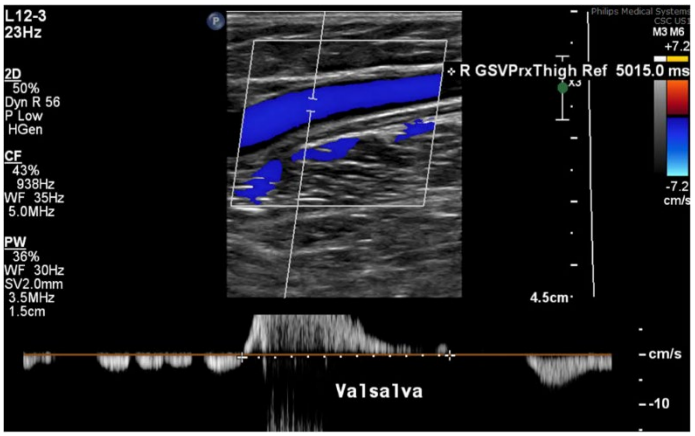
Reflux time using compression in the standing position	
Vein Segment	Abnormal reflux time (sec)
Femoral veins	>1
Popliteal vein	>1
Superficial veins	>.5
Deep calf veins	>.5
Perforating veins	>.35
Reflux time using Valsalva maneuver in 15 degrees reverse Trendelenburg	
Vein Segment	Abnormal reflux time (sec)
Superficial veins	>.5
Greater Saphenous vein	>.5
Common Femoral vein	>1.5
Deep Femoral vein	>.5
Popliteal vein	Not Recommended
Deep calf veins	Not Recommended
Reverse flow velocities	
>30 cm/s	Valve closure occurs within 1sec
<30 cm/s	Reflux may occur as reverse flow persists even in competent valves
Perforating Veins	
< 3.5mm	Normal
≥ 3.5 mm	Abnormal may indicate incompetent perforating veins
Degree of Insufficiency	
Grade	Length of Doppler reflux signal in seconds
I	0.5 – 2.0
II	2.0 – 3.0
III	3.0 – 6.0
IV	Continuous

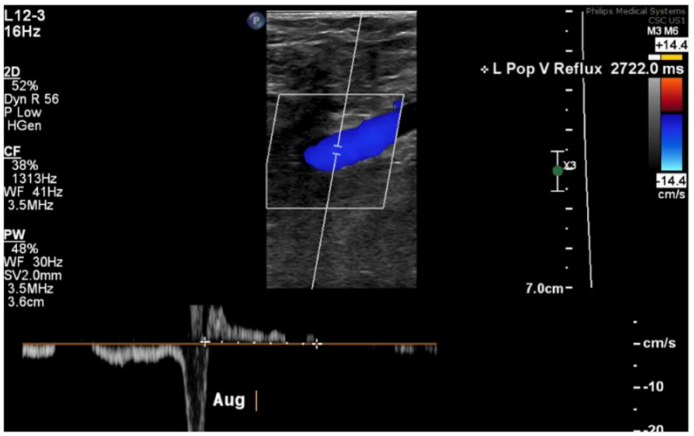
Appendix

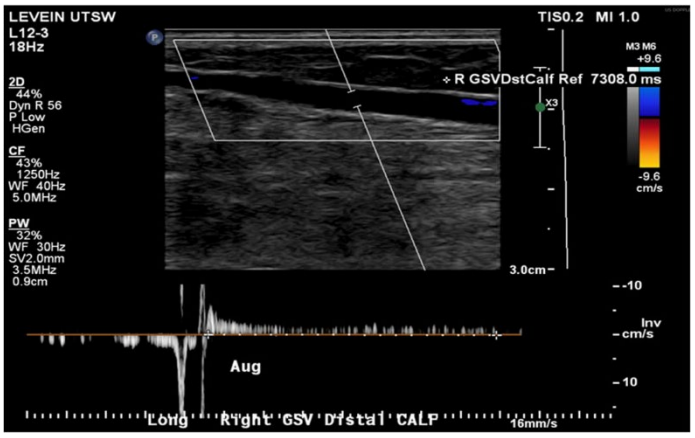
TABLE 1. CEAP Classification of Chronic Venous Disease	
Classification	Description/Definition
C, Clinical (subdivided into A for asymptomatic, S for symptomatic)	
0	No venous disease
1	Telangiectases
2	Varicose veins
3	Edema
4	Lipodermatosclerosis or hyperpigmentation
5	Healed ulcer
6	Active ulcer
E, Etiologic	
Congenital	Present since birth
Primary	Undetermined etiology
Secondary	Associated with post-thrombotic, traumatic
A, Anatomic distribution (alone or in combination)	
Superficial	Great and short saphenous veins
Deep	Cava, iliac, gonadal, femoral, profunda, popliteal, tibial, and muscular veins
Perforator	Thigh and leg perforating veins
P, Pathophysiological	
Reflux	Axial and perforating veins
Obstruction	Acute and chronic
Combination of both	Valvular dysfunction and thrombus

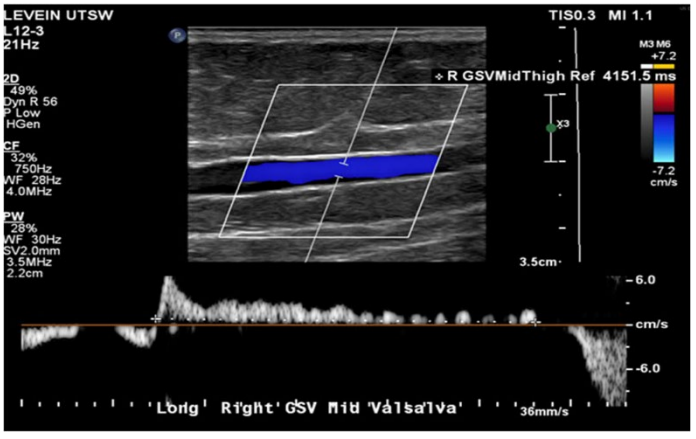
- Prior to performing augmentations, a modified examination must be performed to rule out the presence of DVT, evaluation should include: common femoral vein, proximal greater saphenous, femoral vein, popliteal veins, posterior tibial veins, and peroneal veins.
- Superficial veins must be compressible and patent with no venous thrombosis and minimal diameter of 2mm in order to be considered a good conduit for a bypass graft.
- Chronic outflow obstruction can contribute to venous insufficiency.

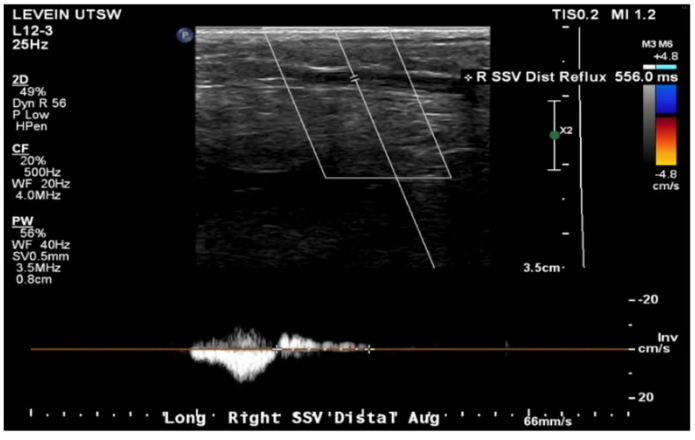
EXAMPLES:

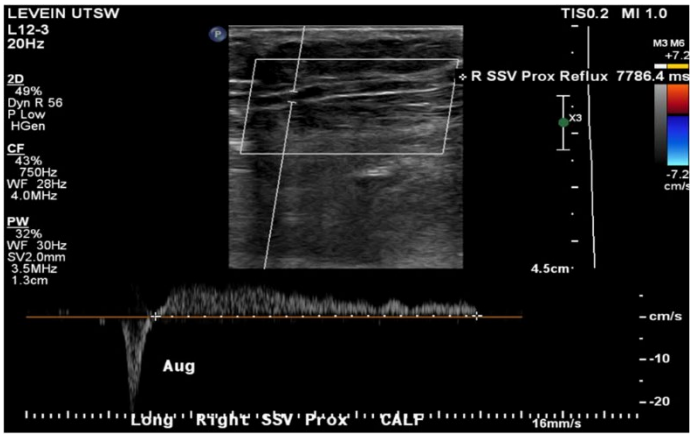

L12-3
23Hz
R GSVPrxThigh Ref 5015.0 ms
Valsalva


L12-3
16Hz
L Pop V Reflux 2722.0 ms
Aug


LEVEIN UTSW
L12-3
18Hz
R GSVDstCalf Ref 7308.0 ms
Aug
Long Right GSV Distal CALF


LEVEIN UTSW
L12-3
21Hz
R GSVMidThigh Ref 4151.5 ms
Long Right GSV Mid Valsalva


LEVEIN UTSW
L12-3
25Hz
R SSV Dist Reflux 556.0 ms
Long Right SSV Distal Aug


LEVEIN UTSW
L12-3
20Hz
R SSV Prox Reflux 7786.4 ms
Aug
Long Right SSV Prox CALF

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