

Ultrasound – Lower Extremity Deep Venous Thrombosis Evaluation

PURPOSE:

To evaluate the lower extremity superficial and deep venous system for the presence of deep venous thrombosis (DVT).

SCOPE:

Applies to all ultrasound studies performed for the evaluation of abdominal or inguinal hernias in:

- UT Southwestern University Hospitals and Clinics, Imaging Services (UTSW)
- Parkland Health, Department of Radiology (PHHS)

ORDERABLES:

- US DOPPLER VENOUS DVT LOWER EXTREMITY BILATERAL
- US DOPPLER VENOUS DVT LOWER EXTREMITY RIGHT
- US DOPPLER VENOUS DVT LOWER EXTREMITY LEFT

INDICATIONS:

- Symptoms such as lower extremity swelling, pain, fever, warmth, change in color, palpable cord
- Prolonged bed rest or immobility
- Suspected DVT based on clinical prediction rules (eg. Well's score or D-Dimer)
- Chest pain and/or shortness of breath; suspected or known pulmonary embolus
- Follow-up known deep venous thrombosis

CONTRAINDICATIONS:

No absolute contraindications

EQUIPMENT:

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.

PATIENT PREPARATION:

- None

EXAMINATION:

GENERAL GUIDELINES:

A complete examination includes evaluation of the deep venous system of the lower extremity from common femoral vein through the popliteal vein (*including calf vein evaluation) and proximal segments of great saphenous and profunda femoral veins.

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:

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- Review any prior imaging, making note of any previous thrombus burden.
- General
 - Proximal and distal refer to the relative distance from the attached end of the limb (proximal femoral vein is closer to hip and distal is closer to knee).
 - Longitudinal axis is parallel to length of vein. Transverse or short axis is perpendicular to long axis of vein.
 - Evaluate entire length of the common femoral vein, femoral vein, and popliteal vein to tibioperoneal trunk. Evaluate proximal deep femoral vein and proximal great saphenous vein (include at least 2 cm segment). **Include calf veins posterior tibial veins (PT) and paired peroneal veins.*
 - For unilateral lower extremity exams, include evaluation of contralateral CFV with spectral Doppler to confirm symmetry of respiratory variation.
 - Note anatomic variations such as duplications.
 - For superficial venous thrombus (SVT) involving the greater or lesser saphenous veins, distance from the proximal-most aspect of the superficial clot to the deep venous confluence may be clinically significant and should be measured.
 - Focal symptoms will generally require evaluation of those area (a focal evaluation is important if Doppler ultrasound did not confirm DVT). This may include: gastrocnemius or soleal veins; nonvascular pathology such as adenopathy, aneurysm, Baker's cyst, hematoma, etc. Include images without/with color Doppler.
- Grayscale Evaluation
 - Optimize grayscale gain and display settings with respect to depth, dynamic range, and focal zones.
 - Adjust dynamic range (image compression) to distinguish artifact from true clot.
 - Refrain from increasing power/gain.
- Doppler
 - Utilize color Doppler with proper color scale and color box size targeted to the vessel under interrogation to support presence or absence of thrombus.
 - Use power Doppler and/or spectral Doppler to confirm absent flow on color Doppler
 - For spectral Doppler, evaluate vessels in long axis with waveform displayed below baseline. Adjust scale to avoid aliasing.
 - For the CFV, respiratory variation should be recorded in all patient. Response to Valsalva useful if waveform is flat, and to check for reflux. If patient is unable to perform Valsalva, abdominal compression should be attempted.
 - For responsive and compliant patients, Valsalva should be maintained for > 1 second. In normal patients, after a brief period of retrograde flow, venous flow should return to baseline until Valsalva is released.
 - If retrograde flow > 1 second is observed, measure reflux time.
 - If a segment of vein is not visualized, include view distal to nonvisualized segment with spectral Doppler (to document respiratory variation) and view proximal to nonvisualized segment with spectral Doppler during distal augmentation (to document flow augmentation across nonvisualized segment).
- Compression
 - Venous compression is applied in transverse plane with adequate pressure on the skin to completely collapse the normal vein lumen.
 - For difficult to visualize vessels, compression images with arrow marking the vein and/or with color Doppler should be included.

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- During ACR accreditation, split screen 2-on-1 images pre- and post-compression should be included for documentation purposes.
- Venous compression is the most diagnostic aspect of this examination. Therefore:
 - 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 nonocclusive 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 veins are poorly seen due to large body habitus or edema, use color Doppler on compression images to identify and highlight the vessels.

DOCUMENTATION:

- Longitudinal images without and with color Doppler (Dual/split screen preferred):
 - Common femoral vein
 - If inaccessible, considering include Common or External Iliac veins
 - Junction of common femoral vein with great saphenous vein
 - Proximal great saphenous vein (include at least 2 cm segment)
 - Proximal femoral vein and proximal deep/profunda femoral vein
 - Mid and distal femoral veins
 - Popliteal vein with tibioperoneal trunk (ie bifurcation)
 - Calf augmentation shall be performed if color Doppler fill-in is incomplete
 - **Posterior tibial and peroneal calf veins*
- Longitudinal images with spectral Doppler:
 - Common femoral vein (with cardiac/respiratory variation. Response to Valsalva or lower abdominal compression must be included for all outpatients, and if no CLEAR cardiac/respiratory variation seen in any patient)
 - For patients able to Valsalva, if retrograde flow (reflux) is > 1 sec, measure reflux duration (time) on spectral waveform;
 - Measure entire time waveform is above baseline (retrograde). **Do not include spectral noise.**
 - For unresponsive or noncompliant patients, measurement not needed;
 - This assessment not needed if abdominal compression is utilized.
 - Popliteal vein
 - Calf augmentation may be performed to improve spectral waveform assessment, but is not required
- Transverse Compression Cine Loops:
 - Common femoral vein
 - Junction of common femoral vein with great saphenous vein
 - Proximal femoral vein and proximal deep/profunda femoral vein
 - Mid femoral vein
 - Distal femoral vein
 - Popliteal vein including tibioperoneal trunk (ie. Bifurcation)

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- **Posterior tibial and peroneal calf veins*
- **TECHNIQUE:**
 - Cine acquisitions during compression.
 - QUICK loop from no compression -> complete collapse -> no compression (within 1-3 seconds)
 - If complete compression not achieved, attempt again (same cine loop)
 - For difficult to visualize vessels, compression images with arrow marking the vein and/or with color Doppler should be included.
- For patients with history of recent venous ablation procedure, evaluate the specific ablated vein(s), evaluating thrombus from its cranial to caudal most extent. Document any residual flow by color Doppler. If color Doppler flow present, obtain spectral waveform with Valsalva.
- When superficial venous thrombus (SVT) of the greater or lesser saphenous veins is identified, measure distance from proximal/cranial most aspect of clot to confluence with deep system (example: distance of clot within greater saphenous to GSV/CFV junction).
- Contralateral common femoral vein for unilateral exams (respiratory variation with response to Valsalva or lower abdominal compression)
- Data page(s)

Anatomy	Grey Scale	Color Doppler	Waveform	Compression
Common femoral vein (CFV)	L	L	L%	T
<i>Common iliac or external iliac vein if CFV inaccessible</i>	L	L	L	
*Contralateral common femoral vein	L	L	L%	
Junction CFV and great saphenous vein	L	L		T
Proximal femoral vein (FV) and deep femoral vein	L	L		T
Mid FV	L	L		T
Distal FV	L	L		T
Popliteal vein	L	L	L	T
Distal popliteal vein with tibioperoneal trunk	L	L		T
Posterior tibial and peroneal veins	L	L*		T*
^GSV/LSV/Other Superficial Veins	L	L	L	
L – Longitudinal; T - Transverse				
* All studies at UTSW. At Parkland, only when signs or symptoms refer to the calves % Without and with Valsalva for outpatients, or for any cooperative patient with flat waveform. If reflux time > 1 sec, measure reflux time. + Not applicable for Bilateral studies. ^ If recent history of superficial venous ablation, interrogate the specific ablated vein for thrombus/residual flow, from proximal to distal most extend. Measure distance from cranial-most aspect of thrombus to confluence with draining deep vein.				

PROCESSING:

- Review examination images and data
- Export all images to PACS
- Document relevant history and any study limitations

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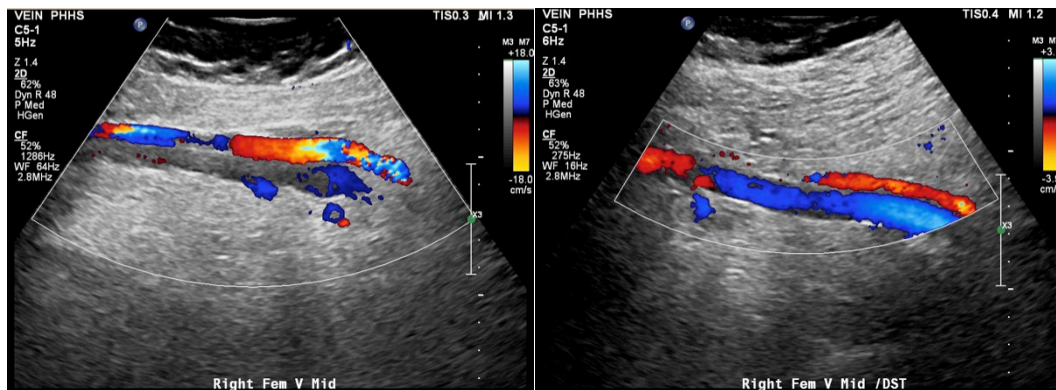
REFERENCES:

ACR-AIUM-SPR-SRU Practice Parameters (Revised 2020)
IAC (ICAVL) Guidelines (Update August 3rd, 2015)
Ultrasound Quarterly, Dec 2005
Radiology Clinics of North America, Vol 52, Issue 6, Nov 2014

APPENDIX:

Exclusion of thrombus in setting of grayscale artifact or slow flow

EXAMPLE 1:

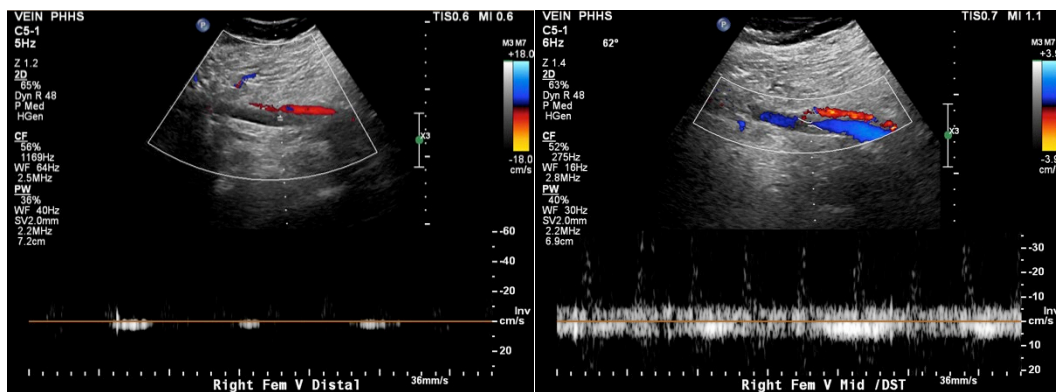


A.

B.

(A) No convincing color Doppler flow is shown in the femoral vein.

(B) Color Doppler shown with appropriate image optimization: color Doppler box decreased in size; Doppler scale decreased; probe heel-toe, allowing for improved Doppler angle.



C.

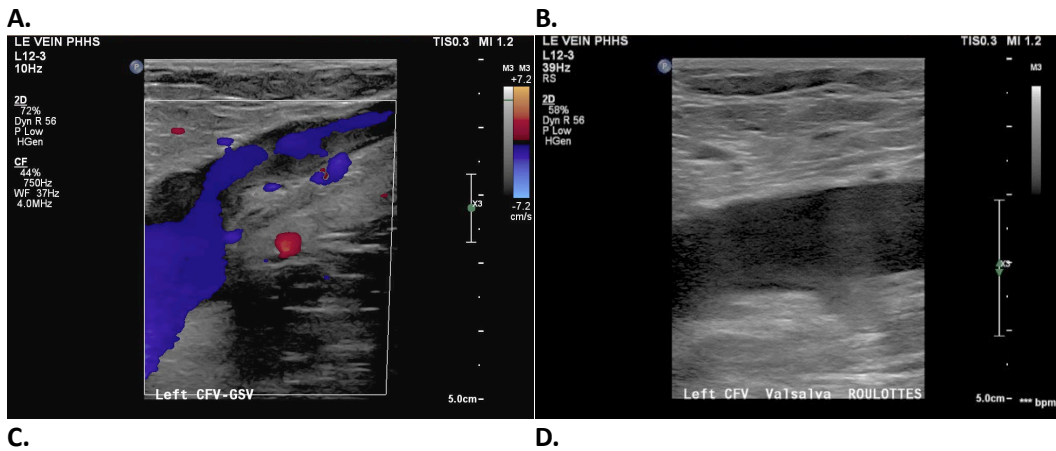
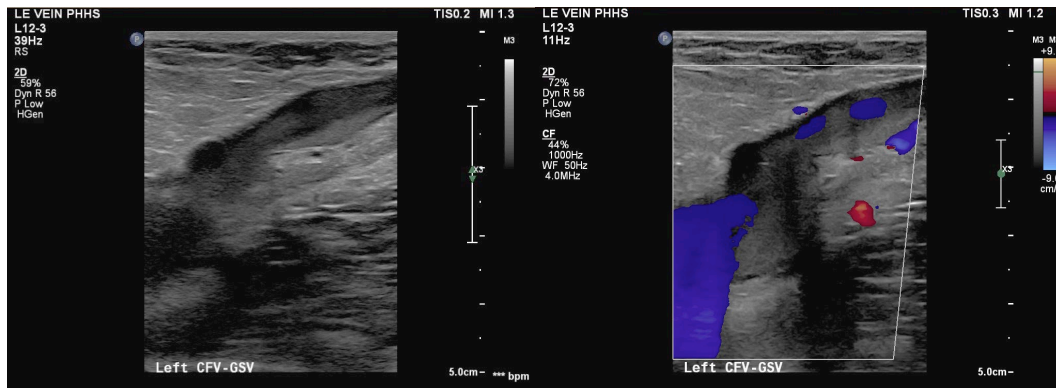
D.

(C) No convincing spectral Doppler flow is shown in the femoral vein.

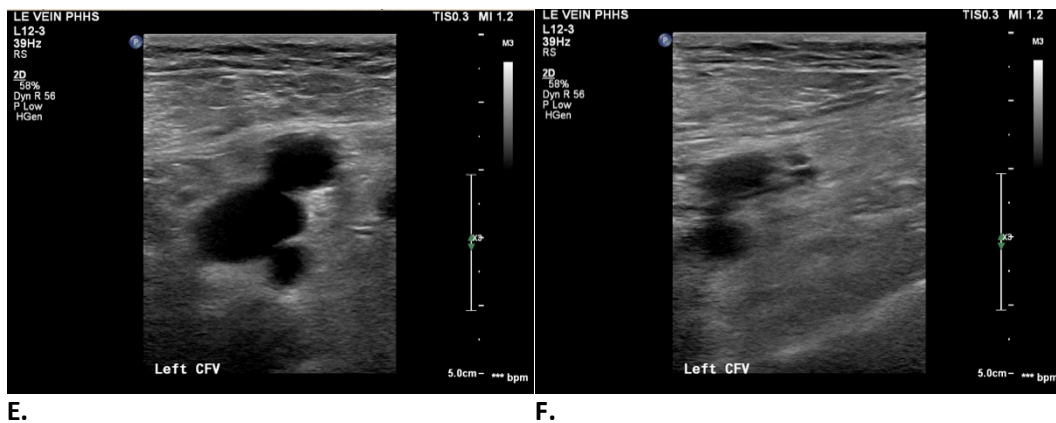
(D) Spectral Doppler flow is shown with decrease in color and spectral Doppler scales; improved angle with probe face; use of angle correction.

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EXAMPLE 2:



(A-C) Echogenic material was seen in the CFV and GSV with incomplete fill-in on color Doppler.
 (D) Slow flow was suspected by Rouleaux artifact, “churning” of low-level echoes in the CFV.



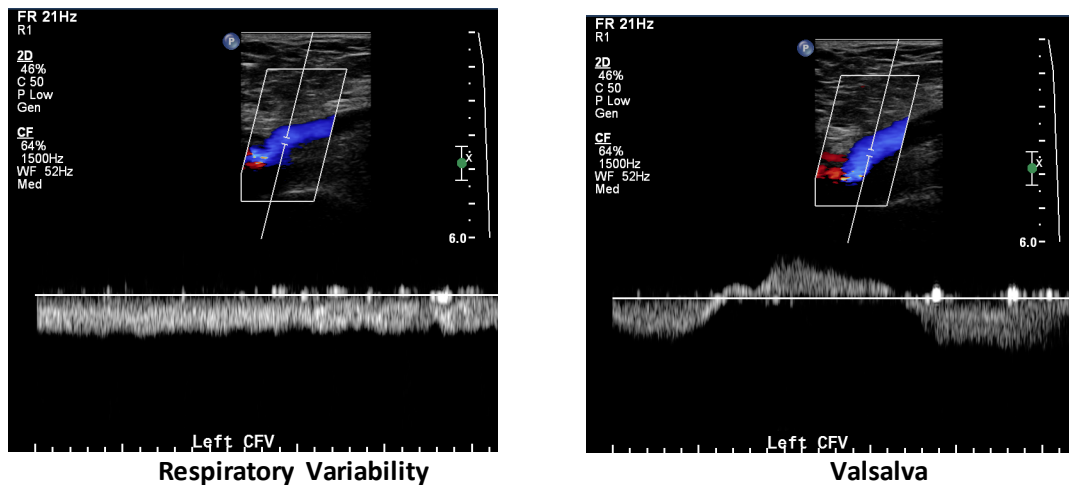
(E-F) Compression was applied. Complete collapse of the CFV (and GSV, not shown) definitively excluded thrombus, confirming artifact from slow flow.

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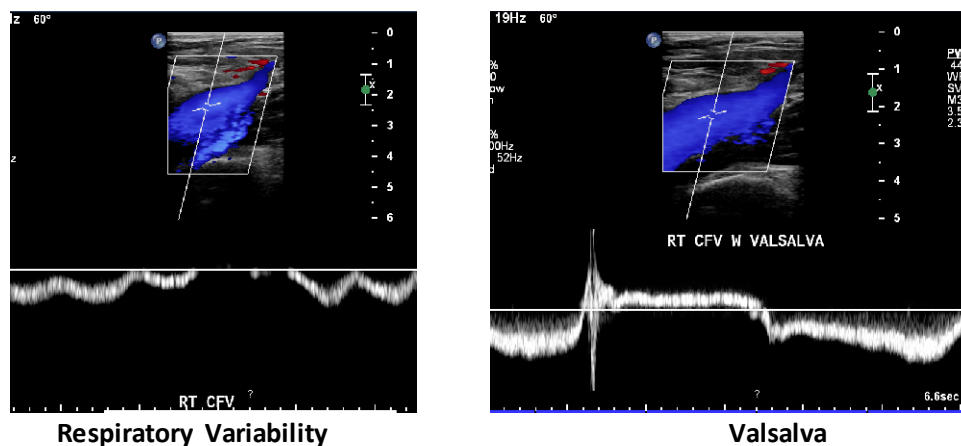
Venous Reflux

Site Protocol: Measure on spectral Doppler waveform, including entire waveform above baseline (retrograde), assuming an appropriate Valsalva. Do not include spectral noise. Assessment not needed for unresponsive or uncooperative patients, or if abdominal compression was utilized. Reflux time > 1 sec (1000 msec) constitutes significant reflux.

Valsalva should be maintained for > 1 second (for compliant, cooperative patients). In normal patients, after a brief period of retrograde flow, venous flow should return to baseline until Valsalva is released. If retrograde flow > 1 second is observed (reflux), measure time of reflux in spectral waveform.



Images show blunted waveform during normal respiration, though normal response to Valsalva. However, prolonged retrograde flow during Valsalva (> 1.5 seconds), suggests venous valvular dysfunction (reflux).



Images show normal respiratory phasicity (right) and response to Valsalva, though with prolonged retrograde flow during Valsalva (nearly 2 seconds), indicating venous valvular dysfunction (reflux).

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REVISION HISTORY:

SUBMITTED BY:	David T. Fetzer, MD	Title	Medical Director
APPROVED BY:	David T. Fetzer, MD	Title	Medical Director
APPROVAL DATE:	11-22-2015		
REVIEW DATE(S):	11-21-2018		David T. Fetzer, MD
REVISION DATE(S):	04-18-2018	Brief Summary	Cine clips of segmental compression now required. Clarified when calf vein imaging needed.
	06-07-2018	Brief Summary	Added color Doppler views of mid, distal femoral vein
	09-19-2018	Brief Summary	Corrected internal discrepancies between text and chart view of required images. Added clarity regarding differences between cine loop and grayscale still requirements
	02-12-2018	Brief Summary	Clarified requirements for contralateral CFV (for unilateral exams)
	05-19-2019	Brief Summary	Added requirements for measuring reflux time in CFV during Valsalva
	05-29-2019	Brief Summary	Clarified requirements for assessing reflux. Added info regarding measurement of distance of SVT to confluence with deep system (eg. distance to GSV/CFV junction).
	12-11-2019		Updates to image order to reflect preferred on-cart protocols. Added information regarding SVT eval s/p venous ablation.
	05-31-2020		Review for brevity and improved workflow
	11-14-2022		Removed ACR requirement for static pre- and post-compression (ACR now allows for cine loops). Removed required for calc augmentation for Popliteal spectral analysis
	04-23-2023		Clarified criteria for calling venous reflux in CFV

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