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 at:
- 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

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TECHNICAL CONSIDERATIONS:

- 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 (ex. 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.
    - Longitudinal images without and with color Doppler (Dual/split screen preferred).
    - Note anatomic variations such as duplications.
    - Evaluate at least 2 cm segment of proximal deep femoral vein and proximal great saphenous vein
    - For unilateral lower extremity exams, include evaluation of contralateral CFV with spectral Doppler to confirm symmetry of respiratory variation.
    - 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(s) (ie. 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.
- 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/cardiac variation should be recorded in all patients.
        - Valsalva for LE DVT studies required if clear and symmetric respiratory and/or cardiac phasicity is not shown (applies both to outpatient and inpatient)
        - 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.
            - 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.
    - 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 non-visualized segment with spectral Doppler during distal augmentation (to document flow augmentation across non-visualized segment).

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    - Popliteal vein - Calf augmentation may be performed to improve spectral waveform assessment, but is not required
- Compression
    - Venous compression is applied in transverse plane with adequate pressure on the skin to completely collapse the normal vein lumen.
        - 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(s) and/or with color Doppler should be included.
    - Venous compression is the most diagnostic aspect of this examination. Therefore:
        - For suspected nonocclusive thrombus or equivocal intraluminal filling defects, compression should be attempted to document compressibility;
        - 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;
        - 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.
- 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 w/ 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).

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DOCUMENTATION:

Anatomy	Grey Scale	Color Doppler	Waveform	Compression
Common femoral vein (CFV) w/ respiratory variation	L	L	L%	T
Common iliac or external iliac vein if CFV inaccessible	L	L	L	
+Contralateral common femoral vein	L	L	L%	
Junction of 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

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% Without and with Valsalva only if respiratory/cardiac variation not seen, 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.

- Data page(s)

PROCESSING:

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

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

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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		Added color Doppler views of mid, distal femoral vein
	09-19-2018		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		Clarified requirements for contralateral CFV (for unilateral exams)
	05-19-2019		Added requirements for measuring reflux time in CFV during Valsalva
	05-29-2019		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
	04-24-2024		Changed reflux from “required” in outpatient exams, to “only when respiratory variation is absent”; Made documentation section more concise; added clarifying info to technical considerations

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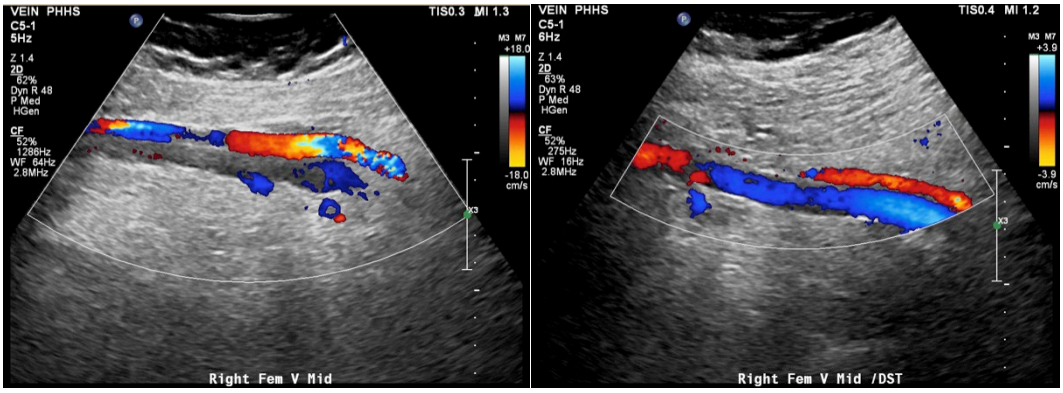
APPENDIX:

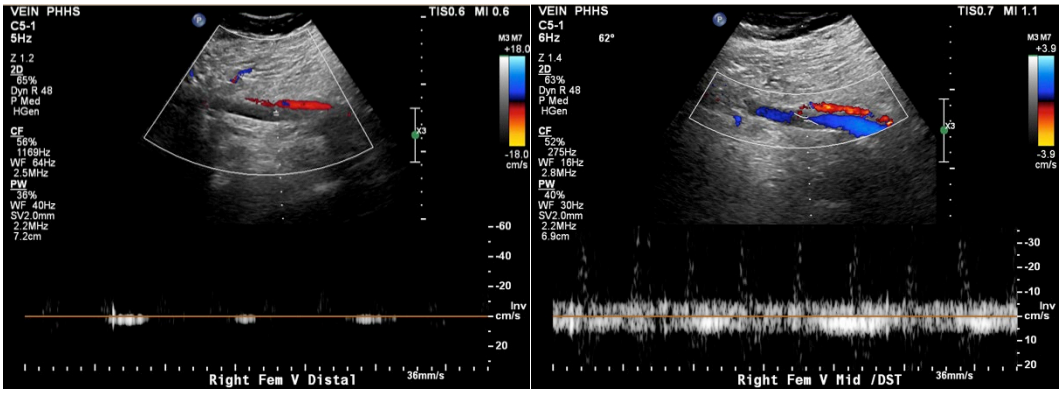
Exclusion of thrombus in setting of grayscale artifact or slow flow

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 deceased; probe heal-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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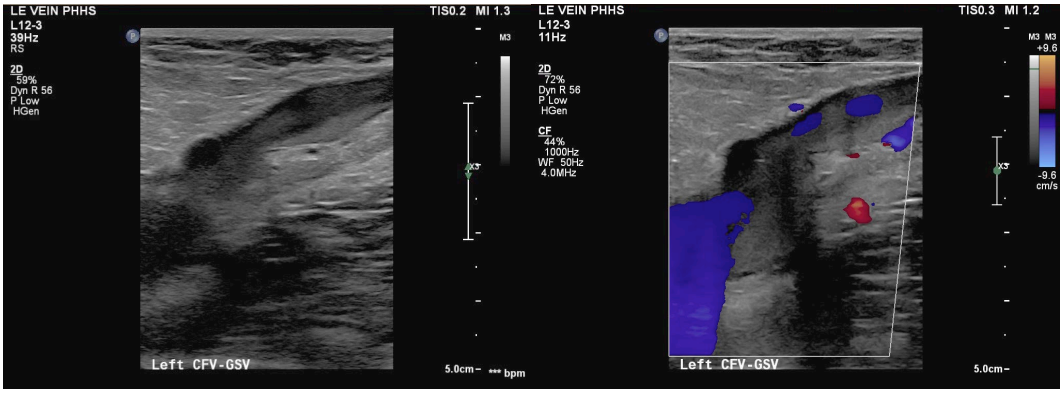
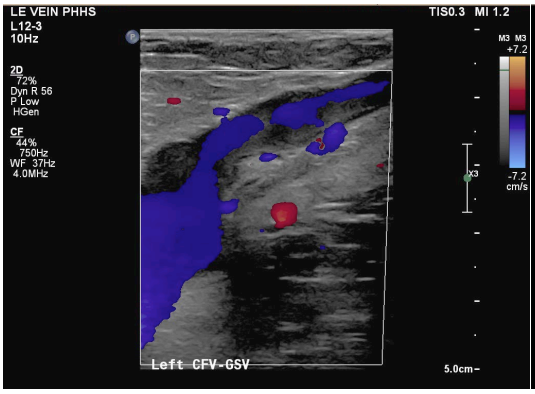
EXAMPLE 2:



A.

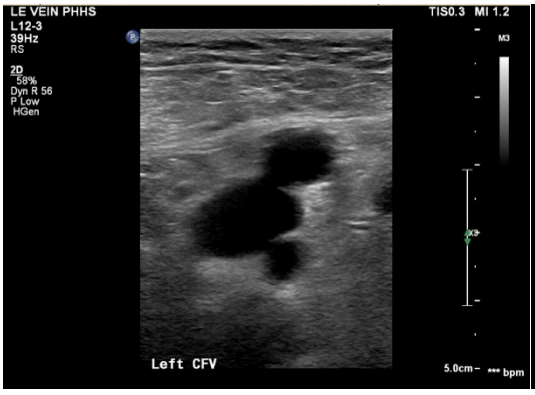
B.



C.

D.

(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.

(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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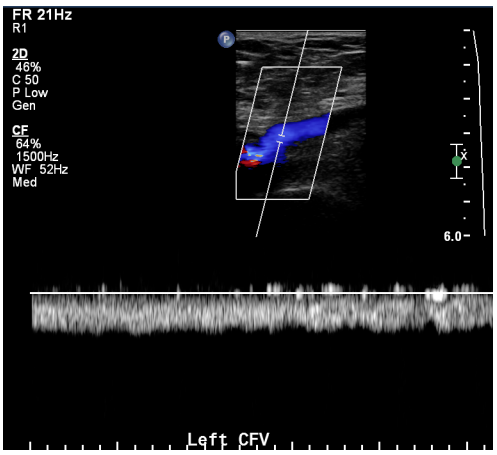
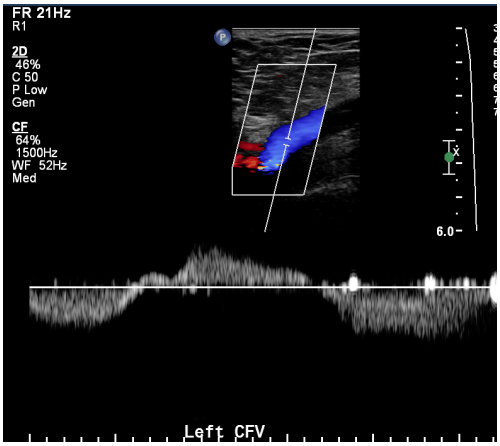
Venous Reflux

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 if clear and symmetric respiratory and/or cardiac phasicity is shown, 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.

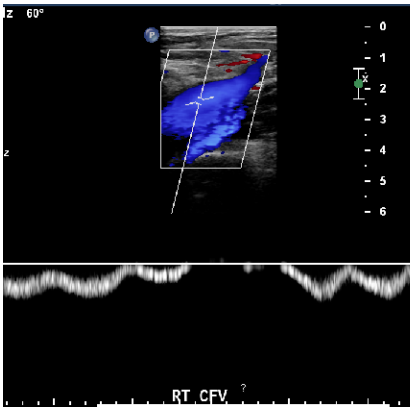


Abnormal Respiratory Variability

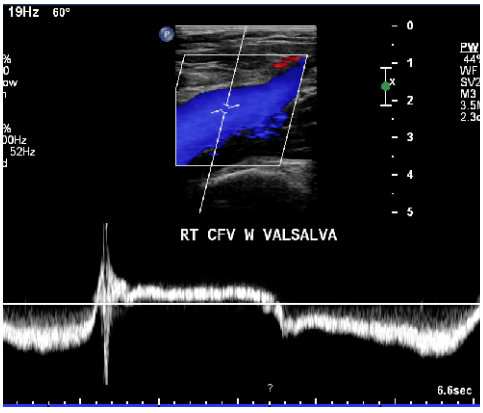


Valsalva

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).



Normal Respiratory Variability



Valsalva

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

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