

Core Modality 3								
Scan Number	Date	Patient Hospital Number	Scan type	Pathology (Y/N)	Aided (A)/ Unaided (U)	Agreement with supervisor? Y/N	Comments, learning points, etc.	AVS Signature
1	February 12, 2024	RRKV425838	Bilateral Leg Primary Vein Scan	N	U	Y	<p>US Doppler lower limb veins Both:</p> <p>RIGHT No acute DVT seen in the CFV, PFV, FV and popliteal veins. The SFJ was incompetent. LSV was stripped from the thigh mid-level segment w/some recurrence of VVs. AASV was refluxing which measures 4.3 mm and straight at a length of approximately 10-12 cm from junction. LSV calf was incompetent. Patent and competent SPJ and SSV.</p> <p>LEFT No acute DVT seen in the CFV, PFV, FV and popliteal veins. The SFJ was incompetent. GSV was refluxing which measures 4.4 mm and straight at a length of approximately 20-25 cm from junction. AASV was also refluxing which appears dilated and tortuous. VV's were fed by LSV and AASV. Patent and competent SPJ and SSV.</p>	Ivan Kalik
2	February 12, 2024	RRKA190516	Left leg Primary Varicose Vein	N	U	Y	<p>US Doppler lower limb veins Lt:</p> <p>No acute DVT and competent CFV, FV and popliteal veins. Patent and competent SFJ and GSV. Patent and competent SPJ and SSV.</p> <p>CONCLUSION Normal deep and superficial veins.</p>	Ivan Kalik
3	February 10, 2024	RRKV694159	Right Leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Rt:</p> <p>No acute DVT and competent CFV, FV and popliteal veins. The SFJ and GSV were patent but incompetent with gross reflux noted. The GSV measured 5.8 mm in diameter, remains within the fascia to knee level and remains straight throughout the thigh. GSV goes superficial and tortuous in the calf and still refluxing. VV's in the calf are fed by the GSV. The SPJ and SSV were patent and competent.</p>	Ivan Kalik

4	February 08, 2024	RRKK657948	Right Leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Rt:</p> <p>No acute DVT and competent CFV, FV and popliteal veins. The SFJ and GSV were patent but incompetent with gross reflux noted. The GSV measured 5.8 mm in diameter, remains within the fascia to knee level and remains straight throughout the thigh and goes superficial and tortuous in the calf and still refluxing. VV's in the calf are fed by the GSV. The SPJ and SSV were patent and competent.</p>	Ivan Kalik
5	February 05, 2024	RRKV379534	Right Leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Rt:</p> <p>Patent and competent CFV, FV, SFV and popliteal veins. Patent SSV and sapheno-popliteal junction.</p> <p>Patent SFJ and GSV however they were seen incompetent with reflux noted. The LSV measured around 6.6 mm in diameter, remains within the fascia to knee level and remains straight throughout the thigh.</p>	Ivan Kalik
6	February 05, 2024	RRKS798093	Left leg Primary Varicose Vein	y	U	Y	<p>US Doppler lower limb veins Lt:</p> <p>GSV was stripped to knee level. Occluded VVs seen in the knee area to proximal calf (known to have foam sclerotherapy 2023). SPJ was competent. SSV was patent and competent. Remaining GSV in the calf was patent and competent.</p>	Ivan Kalik
7	January 30, 2024	RRK1333794	Left leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Lt:</p> <p>Patent and competent deep venous system. Competent SFJ and GSV.</p> <p>Incompetent SPJ. Chronic SSV (partially thrombosed) and incompetent. There was an incompetent trunk connected with SSV that extends above popliteal crease which was refluxing and direct connection could not be seen due to its location which is at 10 cm depth level in ultrasound.</p>	Ivan Kalik
8	January 24, 2023	RRKN065615	Right Leg Primary Varicose Vein	N	U	Y	<p>RIGHT</p> <p>No acute DVT seen in the CFV, FV and popliteal veins. SFJ was competent. GSV was competent throughout. Accessory veins and calf perforator seen were competent. SSV was competent that extends above popliteal crease.</p>	Ivan Kalik

<b>9</b>	January 24, 2023	RRKN065615	Left leg Primary Varicose Vein	N	U	Y	LEFT No acute DVT seen in the CFV, FV and popliteal veins. SFJ was competent. GSV was competent throughout. Accessory veins and calf perforator seen were competent. SSV was competent that extends above popliteal crease.	Ivan Kalik
<b>10</b>	January 24, 2024	RRKK277066	Right Leg Primary Varicose Vein	N	U	Y	RIGHT No acute DVT seen in the CFV, FV and popliteal veins. Not significantly refluxing SFJ and GSV. Anterolateral and posterolateral varices seen was accessory veins of GSV.SSV was competent.	Ivan Kalik
<b>11</b>	January 24, 2024	RRKK277066	Left leg Primary Varicose Vein	N	U	Y	LEFT No acute DVT seen in the CFV, FV and popliteal veins. Stripped GSV thigh. Calf GSV was competent. SSV was competent.	Ivan Kalik
<b>12</b>	January 23, 2024	RRKV076799	Left leg Primary Varicose Vein	Y	U	Y	US Doppler lower limb veins Lt :  No acute DVT seen in the CFV, FV, SFV and popliteal veins. Incompetent SFJ. Incompetent GSV throughout.The GSV is seen straight 15-18 cm distal to inguinal area and measures 4.6mm and then it becomes tortuous at a length of 1 cm in the mid thigh section and runs straight again to knee level.. Competent SSV that shares trunk with gastrocnemius veins.	Ivan Kalik
<b>13</b>	January 23, 2024	RRKG762143	Left leg Primary Varicose Vein	N	U	Y	US Doppler lower limb veins Lt :  RIGHT No acute DVT and competent CFV, FV and popliteal veins. SFJ ligated. Neovascularisation in the groin area. GSV seen was competent with accessory branches (the visible varices in the anteromedial leg) connected. SPJ and SSV were competent.	Ivan Kalik
<b>14</b>	January 23, 2024	RRKG762143	Left leg Primary Varicose Vein	N	U	Y	LEFT No acute DVT and competent CFV, FV and popliteal veins. SFJ ligated. GSV stripped in thigh. There is a short segment GSV left in the thigh. SPJ and SSV were competent.	Ivan Kalik

15	January 22, 2024	RRKK345728	Left leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Lt :</p> <p>The CFV, FV, SFV and popliteal veins were fully compressible with full color flow display. SFJ was refluxing extending to the GSV distal thigh. The thigh GSV measuring 4mm was not straight 12 cm distal to the inguinal area despite seen within fascia. The branches of GSV seen in the thigh was refluxing with connection to varices in the below knee. The GSV in the distal thigh showed hyperechoic intraluminal density within lumen. The GSV below popliteal crease all throughout was competent. The varices seen in the medial calf were refluxing and some of it appeared partially occluded.</p> <p>CONCLUSION No acute DVT. Incompetent SFJ. Incompetent GSV in the thigh. Non-occlusive chronic distal GSV in the thigh. Competent posterior tibial perforator. No true SPJ. Competent SSV.</p>	Ivan Kalik
16	January 22, 2024	RRKV522121	Left leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Lt :</p> <p>No acute DVT and competent CFV, PFV, SV and popliteal veins. GSV was competent. AASV was incompetent throughout and appeared tortuous at approximately 10 cm distal to the groin. Competent SSV.</p>	Ivan Kalik
17	January 22, 2024	RRKS817546	Left leg Primary Varicose Vein	N	U	Y	<p>US Doppler lower limb veins Lt :</p> <p>No acute DVT and competent CFV, FV, SFV and popliteal veins. Main GSV in the thigh was stripped. AASV was tortuous with connection seen to the SSV. SSV remains competent with venous flow drain to SPJ. Both SPJ and SSV were competent.</p>	Ivan Kalik
18	January 18, 2024	RRKS634709	Left leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Lt :</p> <p>No acute DVT seen in the CFV, PFV, SFV and popliteal veins. Competent SFJ. Competent GSV.</p> <p>SPJ was incompetent. SSV was incompetent from popliteal crease to distal calf. The SSV was seen within fascia and straight to the distal calf. The posterior calf varices were seen connected to SSV and via perforator from gastrocnemius.</p>	Ivan Kalik

19	January 18, 2024	RRKK905626	Left leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Lt :</p> <p>No evidence of acute DVT in the CFV, PFV, SFV and popliteal veins. Mildly refluxing CFV of not more than 1.0 second. (&gt;1.0 second to consider significant)</p> <p>SFJ incompetent. Non-occlusive chronic superficial venous thrombosis in the proximal GSV. GSV was incompetent throughout. GSV was measured at 7 mm max AP and was straight. Measurement done in standing position.</p>	Ivan Kalik
20	January 17, 2024	RRKN477164	Right leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Rt :</p> <p>RIGHT</p> <p>No acute DVT seen in the CFV, PFV origin, SFV and popliteal veins. SFJ competent. GSV appears visible in the calf and is incompetent with few small non-thrombosed vessel branches in the calf distal segment. Competent SSV. No true SPJ.</p>	Ivan Kalik
21	January 17, 2024	RRKN477164	Left leg Primary Varicose Vein	N	U	Y	<p>US Doppler lower limb veins Lt :</p> <p>No acute DVT seen in the CFV, PFV origin, SFV and popliteal veins. SFJ was competent. The visible GSV was competent. SSV was competent.</p>	Ivan Kalik
22	January 17, 2024	RRK6005499	Right leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veinsRight:</p> <p>RIGHT</p> <p>No acute DVT seen in the CFV, FV, SFV and popliteal veins. Incompetent SFJ. GSV was straight 3-4 inches from the junction measuring 4.5 cm AP. The GSV from the mid thigh although within fascia was not seen to be linear and straight as it goes distally. Proximal GSV was refluxing and becomes competent from the mid section following a branch that goes superficial. This branch was taking the reflux and rejoins GSV calf therefore making GSV calf competent. Posteromedial calf varices was draining to SSV from the competent GSV making SSV to remain competent and the varices to reflux. Competent SSV.</p>	Ivan Kalik

23	January 17, 2024	RRK6005499	Left leg Primary Varicose Vein	N	U	Y	<p>LEFT</p> <p>No acute DVT seen in the CFV, FV, SFV and popliteal veins. Mild reflux in the SFJ with not more than 1.0 second. Mild reflux noted in the GSV with not more than 1.0 second. Chronic superficial venous thrombosis in the GSV in the distal thigh. Some varices seen in the posterior distal thigh connected to GSV. Competent SSV seen from the popliteal crease to distal calf.</p>	Ivan Kalik
24	January 11, 2024	RRKS628559	Right leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Rt :</p> <p>The CFV, PFV origin, FV and popliteal veins were fully compressible with full color flow display. Refluxing SFJ and GSV throughout. The GSV was seen within fascia however is not straight and becomes tortuous 1.5-2 inches distal from the SFJ. The visible veins seen in the posteromedial area of the distal thigh that extends to the calf is the tortuous dilated GSV with some non-thrombosed branches connected as it goes down distally. No true SPJ. SSV was patent and competent that extends above popliteal crease.</p> <p>CONCLUSION</p> <p>Incompetent SFJ. Incompetent tortuous GSV from proximal thigh and throughout.</p>	Ivan Kalik
25	January 10, 2024	RRKN785489	Left leg Primary Varicose Vein	Y	U	Y	<p>US Doppler lower limb veins Lt :</p> <p>No acute DVT seen in the CFV, FV and popliteal veins. SFJ was refluxing and the anterior accessory vein is taking the reflux making the main GSV competent. The AASV causing varices in the anterior and lateral calf. AASV was seen connected to a perforator in the lateral area and the anterior varices of the distal calf unable to track distally due to small calibre in size. No true SPJ. Patent and competent SSV.</p> <p>CONCLUSION</p> <p>Incompetent AASV. Calf varices (anterior and lateral) connected to AASV were refluxing.</p>	Ivan Kalik

## Venous Duplex Scan (Lower Extremities)

### SCOPE OF INSONATION

✓ **B-mode Transverse View and Compression**

- Distal external iliac vein
- Common femoral vein
- Deep femoral vein
- Great saphenous vein (above knee)
- Femoral vein (proximal, mid, distal)
- Popliteal vein ((proximal, mid, distal)
- Gastrocnemius
- Small saphenous vein
- Posterior tibial vein (proximal, mid, distal)
- Peroneal vein (proximal, mid, distal)
- Anterior tibial vein (proximal, mid, distal)

✓ **Color Mode and Power Doppler (Longitudinal View) of the following segments:**

- Distal external iliac vein
- Common femoral vein
- Sapheno-femoral junction
- Deep femoral vein
- Great saphenous vein (above knee)
- Femoral vein (proximal, mid, distal)
- Popliteal vein ((proximal, mid, distal)
- Sapheno -popliteal junction
- Gastrocnemius

- Small saphenous vein
- Tibio-peroneal trunk
- Posterior tibial vein (proximal, mid, distal)
- Peroneal vein (proximal, mid, distal)
- Anterior tibial vein (proximal, mid, distal)

NOTE: Color Power Angio is used/applied in the blood vessel segment where there is presence of significant finding or abnormality

## Criteria for NORMAL or ABNORMAL

### Four components of the ultrasound surveillance of venous system

1. Visibility
2. Compressibility
3. Venous flow (reflux duration)
4. Augmentation

### NORMAL SONOGRAPHIC FINDINGS

B mode	<p>Complete vein compression</p> <p>Sonolucent venous lumen (echo-free)</p>
Color Doppler	<p>Full color filling (wall to wall)</p> <p>No color filing defect</p> <p>Heartward color flow</p>



Spectral Doppler Analysis	<p>Spontaneous (presence of flow pattern even without external maneuver)</p> <p>Phasic with respiration</p> <p>Flow augments with distal compression</p>
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#### ABNORMAL SONOGRAPHIC FINDINGS

B mode	Incompressible / partial vein compressibility with intraluminal echogenic densities
Color Doppler	<p>Partial color filling of the lumen (color filling defect)</p> <p>Absent color in the lumen</p>
Spectral Doppler Analysis	<p>Absent or reduced flow velocity</p> <p>Continuous, non-phasic waveform pattern</p> <p>Decreased or absent flow augmentation during external compression maneuvers</p> <p>Bidirectional, pulsatile waveform pattern (suggestive of venous hypertension)</p>

#### CHRONICITY OF VENOUS THROMBUS

Acute thrombosis	<p><b>Sonolucent/echolucent</b> : Non-echogenic intraluminal density</p> <p><b>Hypoechoic</b>: Less echogenic compared to the surrounding tissues</p>
Sub-acute thrombosis	<b>Isoechoic</b> : Similar echogenicity as surrounding tissues

	<b>Heterogeneous densities:</b> Areas with less echogenicity and areas with isoechoic densities
Chronic thrombosis	<b>Predominantly hyperechoic densities:</b> Much more echoic than surrounding tissues. May sometimes exhibit posterior acoustic shadowing due to calcification

#### CRITICAL FINDINGS

Acute deep venous thrombosis of the ileo-femoro-popliteal segments

Proximal propagation of known DVT

Great saphenous vein thrombosis within 2 cm from saphenofemoral junction

Evidence of phlegmasia

Significant arterial pathology

#### Indirect findings of a more proximal venous outflow occlusion (suprainguinal)

- Asymmetry in flow velocity
- Lack of respiratory variations in venous flow (continuous flow) and waveform patterns at rest
- Lack of velocity acceleration during flow augmentation the CFV

#### REFLUX CRITERIA

Deep veins (above popliteal vein)- equal to or greater than 1 second

Deep veins (popliteal and below)- equal to or greater than 0.5 second

Saphenous veins and junctions

Perforators

-equal to or greater than 0.35 second

**“Pathologic” perforating veins**

- Outward flow of duration of  $\geq 500$  ms
- Diameter of  $>3.5$ mm
- Location beneath healed or open venous ulcers

Assessing Acuteness of DVT	<b>Acute</b> <ul style="list-style-type: none"><li>• Within first 2 weeks after the thrombus has formed.</li></ul>	<ul style="list-style-type: none"><li>• Vein non-compressibility</li><li>• Soft thrombus, deformable with probe pressure</li><li>• In general, the surface of the thrombus is smooth and the vein is larger than normal.</li><li>• Loosely adherent or free floating edge may be seen.</li></ul>
	<b>Subacute</b> <ul style="list-style-type: none"><li>• <math>&gt;2</math> weeks and potentially after 6 months after thrombus formation.</li></ul>	<ul style="list-style-type: none"><li>• Should be rarely used and should only be reported for a follow-up study only if:<ol style="list-style-type: none"><li>1. There is a previous ultrasound demonstrating acute thrombus weeks earlier.</li><li>2. The new study shows a change in appearance of thrombosis that is not typical of chronic post-thrombotic change.</li></ol></li></ul>
	<b>Indeterminate of Equivocal findings</b>	<ul style="list-style-type: none"><li>• When there is criteria conflict which cannot be reconciled.</li><li>• Must be used sparingly.</li></ul>
	<b>“Chronic post-thrombotic changes”</b>	<ul style="list-style-type: none"><li>• Non-compressible, but the intraluminal material is rigid and</li></ul>

	<ul style="list-style-type: none"> <li>• Preferred term over residual or chronic thrombus to avoid being misinterpreted by providers as persistent of acute thrombus that leads to inappropriate anticoagulation.</li> <li>• Usually after 6 months.</li> </ul>	<p>non-deformable with probe pressure</p> <ul style="list-style-type: none"> <li>• The surface may be irregular, and calcifications may rarely be noted.</li> <li>• Material may retract, with irregular and produce thin webs or thicker flat bands.</li> <li>• Incorporated or attached to the walls or recanalization may produce regular or irregular wall thickening.</li> <li>• Vein size may be normal or decreased.</li> </ul>
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**OTHER INDICATIONS OF ABNORMAL FINDINGS**

Presence of hematoma, varicosities, edema, abnormal waveform (pulsatile)prominent lymph nodes, ulcers and stasis

**Venous Compression Test (Lower Extremities)**

**SCOPE OF INSONATION**

- ✓ **B-mode Transverse View and Compression**
  - Distal external iliac vein
  - Common femoral vein
  - Deep femoral vein
  - Great saphenous vein (above knee)

- Femoral vein (proximal, mid, distal)
- Popliteal vein ((proximal, mid, distal)
- Gastrocnemius
- Small saphenous vein
- Posterior tibial vein (proximal, mid, distal)
- Peroneal vein (proximal, mid, distal)
- Anterior tibial vein (proximal, mid, distal)

✓ **Color Mode (Longitudinal View) of the following segments:**

- Distal external iliac vein
- Common femoral vein
- Sapheno-femoral junction
- Deep femoral vein
- Great saphenous vein (above knee)
- Femoral vein (proximal, mid, distal)
- Popliteal vein ((proximal, mid, distal)
- Sapheno -popliteal junction
- Gastrocnemius
- Small saphenous vein
- Tibio-peroneal trunk
- Posterior tibial vein (proximal, mid, distal)
- Peroneal vein (proximal, mid, distal)
- Anterior tibial vein (proximal, mid, distal)

NOTE: Color Power Angio is used/applied in the blood vessel segment where there is presence of significant finding or abnormality

## **Criteria for NORMAL or ABNORMAL**

#### **Four components of the ultrasound surveillance of venous system**

1. Visibility
2. Compressibility
3. Venous flow (reflux duration)
4. Augmentation

#### **Indirect findings of a more proximal venous outflow occlusion (suprainguinal)**

- Assymetry in flow velocity
- Lack of respiratory variations in venous flow (continuous flow) and waveform patterns at rest
- Lack of velocity acceleration during flow augmentation the CFV

#### **“Pathologic” perforating veins**

- Outward flow of duration of  $\geq 500$  ms
- Diameter of  $>3.5$  mm
- Location beneath healed or open venous ulcers

#### **NORMAL SONOGRAPHIC FINDINGS**

B mode	Complete vein compression Sonolucent venous lumen (echo-free)
Color Doppler	Full color filling (wall to wall) No color filling defect Heartward color flow
Spectral Doppler Analysis	Spontaneous (presence of flow pattern even without external maneuver)

	<p>Phasic with respiration</p> <p>Flow augments with distal compression</p>
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#### ABNORMAL SONOGRAPHIC FINDINGS

B mode	Incompressible / partial vein compressibility with intraluminal echogenic densities
Color Doppler	<p>Partial color filling of the lumen (color filling defect)</p> <p>Absent color in the lumen</p>
Spectral Doppler Analysis	<p>Absent or reduced flow velocity</p> <p>Continuous, non-phasic waveform pattern</p> <p>Decreased or absent flow augmentation during external compression maneuvers</p> <p>Bidirectional, pulsatile waveform pattern (suggestive of venous hypertension)</p>

#### CHRONICITY OF VENOUS THROMBUS

Acute thrombosis	<p><b>Sonolucent/echolucent</b> : Non-echogenic intraluminal density</p> <p><b>Hypoechoic</b>: Less echogenic compared to the surrounding tissues</p>
Sub-acute thrombosis	<p><b>Isoechoic</b>: Similar echogenicity as surrounding tissues</p> <p><b>Heterogeneous densities</b>: Areas with less echogenicity and areas with isoechoic densities</p>

Chronic thrombosis	<b>Predominantly hyperechoic densities:</b> Much more echoic than surrounding tissues. May sometimes exhibit posterior acoustic shadowing due to calcification	
<div>CRITICAL FINDINGS</div> <div>Acute deep venous thrombosis of the ileo-femoro-popliteal segments</div> <div>Proximal propagation of known DVT</div> <div>Great saphenous vein thrombosis within 2 cm from saphenofemoral junction</div> <div>Evidence of phlegmasia</div> <div>Significant arterial pathology</div>		
Assessing Acuteness of DVT	<b>Acute</b> <ul style="list-style-type: none"><li>Within first 2 weeks after the thrombus has formed.</li></ul>	<ul style="list-style-type: none"><li>Vein non-compressibility</li><li>Soft thrombus, deformable with probe pressure</li><li>In general, the surface of the thrombus is smooth and the vein is larger than normal.</li><li>Loosely adherent or free floating edge may be seen.</li></ul>
	<b>Subacute</b> <ul style="list-style-type: none"><li>&gt;2 weeks and potentially after 6 months after thrombus formation.</li></ul>	<ul style="list-style-type: none"><li>Should be rarely used and should only be reported for a follow-up study only if:</li></ul>



		<ol style="list-style-type: none"> <li>1. There is a previous ultrasound demonstrating acute thrombus weeks earlier.</li> <li>2. The new study shows a change in appearance of thrombosis that is not typical of chronic post-thrombotic change.</li> </ol>
	<b>Indeterminate of Equivocal findings</b>	<ul style="list-style-type: none"> <li>• When there is criteria conflict which cannot be reconciled.</li> <li>• Must be used sparingly.</li> </ul>
	<b>"Chronic post-thrombotic changes"</b> <ul style="list-style-type: none"> <li>• Preferred term over residual or chronic thrombus to avoid being misinterpreted by providers as persistent of acute thrombus that leads to inappropriate anticoagulation.</li> <li>• Usually after 6 months.</li> </ul>	<ul style="list-style-type: none"> <li>• Non-compressible, but the intraluminal material is rigid and non-deformable with probe pressure</li> <li>• The surface may be irregular, and calcifications may rarely be noted.</li> <li>• Material may retract, with irregular and produce thin webs or thicker flat bands.</li> <li>• Incorporated or attached to the walls or recanalization may produce regular or irregular wall thickening.</li> <li>• Vein size may be normal or decreased.</li> </ul>

#### **OTHER INDICATIONS OF ABNORMAL FINDINGS**

Presence of hematoma, varicosities, edema, abnormal waveform (pulsatile) prominent lymph nodes, ulcers and stasis

## Venous Duplex Scan (Upper Extremities)

### SCOPE OF INSONATION

#### ✓ B-mode Transverse View and Compression

- Internal jugular vein
- Subclavian vein (proximal, mid, distal) *\*if there is a finding*
- Axillary vein *\*if there is a finding*
- Brachial vein (proximal, mid, distal)
- Radial vein (proximal, mid, distal)
- Ulnar vein (proximal, mid, distal)
- Cephalic vein (arm and forearm)
- Basilic vein (arm and forearm)

#### ✓ Color Mode and Pulse Wave Doppler (Longitudinal View) of the following segments:

- Internal jugular vein
- Subclavian vein (proximal, mid, distal)
- Axillary vein
- Brachial vein (proximal, mid, distal)
- Radial vein (proximal, mid, distal)
- Ulnar vein (proximal, mid, distal)
- Cephalic vein (arm and forearm)
- Basilic vein (arm and forearm)

NOTE: Color Power Angio is used/applied in the blood vessel segment where there is presence of significant finding or abnormality

## Criteria for NORMAL or ABNORMAL

### Four components of the ultrasound surveillance of venous system

1. Visibility
2. Compressibility
3. Venous flow (reflux duration)
4. Augmentation

### REFLUX CRITERIA- Not applicable

#### NORMAL SONOGRAPHIC FINDINGS

B mode	Complete vein compression Sonolucent venous lumen (echo-free)
Color Doppler	Full color filling (wall to wall) No color filing defect Heartward color flow
Spectral Doppler Analysis	Spontaneous (presence of flow pattern even without external maneuver) Phasic with respiration

	Flow augments with distal compression
<b>ABNORMAL SONOGRAPHIC FINDINGS</b>	
B mode	Incompressible / partial vein compressibility with intraluminal echogenic densities
Color Doppler	Partial color filling of the lumen (color filling defect)  Absent color in the lumen
Spectral Doppler Analysis	Absent or reduced flow velocity  Continuous, non-phasic waveform pattern  Decreased or absent flow augmentation during external compression maneuvers  Bidirectional, pulsatile waveform pattern (suggestive of venous hypertension)
<b>CHRONICITY OF VENOUS THROMBUS</b>	
Acute thrombosis	<b>Sonolucent/echolucent</b> : Non-echogenic intraluminal density  <b>Hypoechoic</b> : Less echogenic compared to the surrounding tissues
Sub-acute thrombosis	<b>Isoechoic</b> : Similar echogenicity as surrounding tissues  <b>Heterogeneous densities</b> : Areas with less echogenicity and areas with isoechoic densities

Chronic thrombosis	<b>Predominantly hyperechoic densities:</b> Much more echoic than surrounding tissues. May sometimes exhibit posterior acoustic shadowing due to calcification	
Assessing Acuteness of DVT	<b>Acute</b> <ul style="list-style-type: none"> <li>Within first 2 weeks after the thrombus has formed.</li> </ul>	<ul style="list-style-type: none"> <li>Vein non-compressibility</li> <li>Soft thrombus, deformable with probe pressure</li> <li>In general, the surface of the thrombus is smooth and the vein is larger than normal.</li> <li>Loosely adherent or free floating edge may be seen.</li> </ul>
	<b>Subacute</b> <ul style="list-style-type: none"> <li>&gt;2 weeks and potentially after 6 months after thrombus formation.</li> </ul>	<ul style="list-style-type: none"> <li>Should be rarely used and should only be reported for a follow-up study only if:               <ol style="list-style-type: none"> <li>There is a previous ultrasound demonstrating acute thrombus weeks earlier.</li> <li>The new study shows a change in appearance of thrombosis that is not typical of chronic post-thrombotic change.</li> </ol> </li> </ul>
	<b>Indeterminate or Equivocal findings</b>	<ul style="list-style-type: none"> <li>When there is criteria conflict which cannot be reconciled.</li> <li>Must be used sparingly.</li> </ul>
	<b>“Chronic post-thrombotic changes”</b> <ul style="list-style-type: none"> <li>Preferred term over residual or chronic thrombus to avoid being misinterpreted by providers as persistent of acute thrombus that leads to inappropriate anticoagulation.</li> <li>Usually after 6 months.</li> </ul>	<ul style="list-style-type: none"> <li>Non-compressible, but the intraluminal material is rigid and non-deformable with probe pressure</li> <li>The surface may be irregular, and calcifications may rarely be noted.</li> </ul>

		<ul style="list-style-type: none"> <li>• Material may retract, with irregular and produce thin webs or thicker flat bands.</li> <li>• Incorporated or attached to the walls or recanalization may produce regular or irregular wall thickening.</li> <li>• Vein size may be normal or decreased.</li> </ul>
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### OTHER INDICATIONS OF ABNORMAL FINDINGS

Presence of hematoma, varicosities, edema, abnormal waveform (pulsatile) prominent lymph nodes, ulcers and stasis

## Venous Compression Test (Upper Extremities)

### SCOPE OF INSONATION

#### ✓ B-mode Transverse View and Compression

- Internal jugular vein
- Subclavian vein (proximal, mid, distal) *\*if there is a finding*
- Axillary vein *\*if there is a finding*
- Brachial vein (proximal, mid, distal)
- Radial vein (proximal, mid, distal)
- Ulnar vein (proximal, mid, distal)
- Cephalic vein (arm and forearm)
- Basilic vein (arm and forearm)

✓ **Color Mode (Longitudinal View) of the following segments:**

- Internal jugular vein
- Subclavian vein (proximal, mid, distal)
- Axillary vein
- Brachial vein (proximal, mid, distal)
- Radial vein (proximal, mid, distal)
- Ulnar vein (proximal, mid, distal)
- Cephalic vein (arm and forearm)
- Basilic vein (arm and forearm)

NOTE: Color Power Angio is used/applied in the blood vessel segment where there is presence of significant finding or abnormality

## **Criteria for NORMAL or ABNORMAL**

### **Four components of the ultrasound surveillance of venous system**

1. Visibility
2. Compressibility
3. Venous flow (reflux duration)
4. Augmentation

#### **NORMAL SONOGRAPHIC FINDINGS**

B mode	Complete vein compression Sonolucent venous lumen (echo-free)
Color Doppler	Full color filling (wall to wall) No color filing defect

	Heartward color flow
Spectral Doppler Analysis	Spontaneous (presence of flow pattern even without external maneuver)  Phasic with respiration  Flow augments with distal compression

#### ABNORMAL SONOGRAPHIC FINDINGS

B mode	Incompressible / partial vein compressibility with intraluminal echogenic densities
Color Doppler	Partial color filling of the lumen (color filling defect)  Absent color in the lumen
Spectral Doppler Analysis	Absent or reduced flow velocity  Continuous, non-phasic waveform pattern  Decreased or absent flow augmentation during external compression maneuvers  Bidirectional, pulsatile waveform pattern (suggestive of venous hypertension)

#### CHRONICITY OF VENOUS THROMBUS

Acute thrombosis	<b>Sonolucent/echolucent</b> : Non-echogenic intraluminal density  <b>Hypoechoic</b> : Less echogenic compared to the surrounding tissues
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Sub-acute thrombosis	<p><b>Isoechoic:</b> Similar echogenicity as surrounding tissues</p> <p><b>Heterogeneous densities:</b> Areas with less echogenicity and areas with isoechoic densities</p>
Chronic thrombosis	<p><b>Predominantly hyperechoic densities:</b> Much more echoic than surrounding tissues. May sometimes exhibit posterior acoustic shadowing due to calcification</p>

Assessing Acuteness of DVT	<p><b>Acute</b></p> <ul style="list-style-type: none"> <li>• Within first 2 weeks after the thrombus has formed.</li> </ul>	<ul style="list-style-type: none"> <li>• Vein non-compressibility</li> <li>• Soft thrombus, deformable with probe pressure</li> <li>• In general, the surface of the thrombus is smooth and the vein is larger than normal.</li> <li>• Loosely adherent or free floating edge may be seen.</li> </ul>
	<p><b>Subacute</b></p> <ul style="list-style-type: none"> <li>• &gt;2 weeks and potentially after 6 months after thrombus formation.</li> </ul>	<ul style="list-style-type: none"> <li>• Should be rarely used and should only be reported for a follow-up study only if: <ol style="list-style-type: none"> <li>1. There is a previous ultrasound demonstrating acute thrombus weeks earlier.</li> <li>2. The new study shows a change in appearance of thrombosis that is not typical of chronic post-thrombotic change.</li> </ol> </li> </ul>
	<p><b>Indeterminate of Equivocal findings</b></p>	<ul style="list-style-type: none"> <li>• When there is criteria conflict which cannot be reconciled.</li> <li>• Must be used sparingly.</li> </ul>
	<p><b>“Chronic post-thrombotic changes”</b></p>	<ul style="list-style-type: none"> <li>• Non-compressible, but the intraluminal material is rigid and</li> </ul>

	<ul style="list-style-type: none"> <li>• Preferred term over residual or chronic thrombus to avoid being misinterpreted by providers as persistent of acute thrombus that leads to inappropriate anticoagulation.</li> <li>• Usually after 6 months.</li> </ul>	<p>non-deformable with probe pressure</p> <ul style="list-style-type: none"> <li>• The surface may be irregular, and calcifications may rarely be noted.</li> <li>• Material may retract, with irregular and produce thin webs or thicker flat bands.</li> <li>• Incorporated or attached to the walls or recanalization may produce regular or irregular wall thickening.</li> <li>• Vein size may be normal or decreased.</li> </ul>
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#### OTHER INDICATIONS OF ABNORMAL FINDINGS

Presence of hematoma, varicosities, edema, abnormal waveform (pulsatile) prominent lymph nodes, ulcers and stasis

## Venous Mapping (Pre-Bypass)

#### SCOPE OF INSONATION

- ✓ First, perform **full study of venous duplex procedure** in bilateral lower extremities
- ✓ Use skin marker to track location of saphenous veins
- ✓ Measure in B-mode the cross sectional(transverse) and anteroposterior walls (longitudinal view) of the following segments:
  - Great saphenous vein above knee (proximal, mid, distal)
  - Great saphenous vein below knee (proximal, mid, distal)
  - Small saphenous vein

In general, veins must be a minimum of 2.0 mm in diameter to be adequate for use as a

bypass conduit.

## Arterial and Venous Mapping (AVF/Fistula Creation)

- ✓ First, perform **arterial duplex scan and venous duplex scan protocol** in either bilateral upper extremity (baseline)
- ✓ Apply tourniquet in armpit section for 5 minutes and measure the following:
  - Axillary vein
  - Brachial vein (proximal, mid, distal)
  - Radial vein (proximal, mid, distal)
  - Ulnar vein (proximal, mid, distal)
  - Cephalic vein (arm and forearm)
  - Basilic vein (arm and forearm)
- ✓ Measure anterior and posterior wall in both transverse and longitudinal view of the following:
  - Subclavian artery (proximal, mid, distal)
  - Axillary artery
  - Brachial artery (proximal, mid, distal)
  - Radial artery (proximal, mid, distal)
  - Ulnar artery (proximal, mid, distal)

## Criteria for NORMAL

If all of the following criteria are met.

**VENOUS AND ARTERIAL SEGMENTS OF THE UPPER EXTREMITY  
REQUIREMENT FOR SUITABILITY FOR DIALYSIS ACCESS PLACEMENT**

**SUPERFICIAL VEIN CRITERIA**

Venous luminal diameter for AVF creation	2.5 mm and above
Venous luminal diameter for Graft creation	4.0 mm and above
Vein depth from skin	Ideally should be 5 -10 mm from skin surface for easier cannulation
<b>ARTERY CRITERIA</b>	
Arterial diameter for inflow anastomosis	2.0 mm and above
Arterial waveform pattern	Triphasic
<p><b>Criteria for ABNORMAL</b></p> <p>at least one of the following required measurements are not met</p> <p><b>OTHER PERTINENT CRITERIA</b></p> <p>Pulsatile venous flow pattern in the axillosubclavian veins</p> <p><i>Continuous venous flow with diminished or absent pulsatility in the segments is suggestive of central venous stenosis or occlusion</i></p> <p>Continuity of superficial veins with proximal central veins</p> <p>Absence of obstruction along the superficial veins</p> <p>High resistance arterial waveform pattern in the arm arteries</p> <p><i>Low resistance waveform pattern with delayed systolic peak (tardus parvus) is suggestive of hemodynamically significant proximal arterial stenosis or occlusion</i></p>	

## PROTOCOL USED FROM JANUARY 31, 2023- PRESENT

### Lower Limb Arterial Duplex Ultrasound

#### Purpose

Duplex ultrasound examination is used to assess the arteries of the lower limb (aorta to ankle level) to determine the location and severity of vascular disease (occlusive and aneurysmal).

#### Common Indications

- Common indications for the performance of this examination include:
- Intermittent claudication.
- Ischemic rest pain.
- Gangrene.
- Ulceration.
- Post-surgical intervention follow-up e.g. angioplasty.
- Aneurysm.
- False aneurysm.

#### Contraindications and Limitations

Contraindications for lower limb arterial duplex ultrasound assessment are unlikely; however, some limitations exist and may include the following:

- Body habitus
- Casts, dressings, open wounds etc.
- Bowel gas when examining the aorto-iliac segment. Calcified arteries resulting from atherosclerosis may obstruct the ultrasound beam and cause acoustic shadowing artefact and may limit Doppler assessment.
- Patients who are unable to cooperate due to reduced cognitive functions e.g.
  - Alzheimer's or dementia and through involuntary movements.

#### Equipment

- Duplex Doppler ultrasound machine with imaging frequencies of 3.5MHz and greater; with both linear and curvilinear transducers available<sup>1</sup>.
- Doppler frequencies of at least 3.0MHz should be available, with colour Doppler capability.
  - Compliance with the Medical Devices Directive is necessary.
  - Electrical safety testing is required annually, with regular maintenance and quality assurance testing to specified level by qualified personnel.
  - Examination couch should be height adjustable preferably electrical. The scanning chair should provide good lumbar support, be height

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adjustable and allow for the operator to move close to the examination couch<sup>23</sup>.

- The examination room should be temperature controlled with adjustable lighting levels suitable for examination<sup>2</sup>.
- Suitable cleaning materials should be available in line with local and manufactures guidelines.

## Explanation of examination and patient history

The staff member undertaking the examination should:

- Welcome the patient and relatives.
- Introduce themselves and any other members of staff in the room.
- Confirm the patient's identity e.g. full name and date of birth
- Explain why the examination is being performed and give an indication of the test's duration
- Give an explanation of the procedure and it's duration – consideration should be made to the age and mental status of the patient
- Obtain verbal consent for the examination.
- Obtain a pertinent relevant medical history from the patient and/or notes
  - Identify presence of any risk factors for example Smoking; diabetes; high cholesterol; obesity; hypertension; cardiovascular disease.
  - Verify that the requested procedure correlates with the patient's clinical presentation.
- The test can be terminated at any point if the patient withdraws their consent for the procedure.
- Post procedure the patient must be informed how, when and by whom results/reports will be communicated.

## Examination

- During the examination patients must be treated with respect, dignity and discretion.
  - Patient comfort should be monitored throughout the test and alterations be made should a patient become uncomfortable.
  - The examination may be unilateral or bilateral dependent upon clinical symptoms.
- The patient is asked to remove their clothing to expose the lower limb from groin to ankle.

- The patient is examined supine.
- The patient's dignity and privacy should be maintained at all times. Due to intimate nature of the examination it may be considered necessary to offer a chaperone<sup>4</sup>.
- During the examination the patient's mental and physical status should be monitored and modifications made to the examination accordingly.

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- B-mode should be used to image the artery and assess for, aneurysmal dilation and vessel contents e.g. athermanous plaque.
- Spectral Doppler should be used to determine direction of flow, stenotic flow and absence of flow.
- Colour Doppler should be used to assess for the presence/absence of flow and aid the position of spectral Doppler when quantifying stenosis.
- A 50-75% stenosis is defined as a ratio of 2 but less than 2.5 when the peak systolic velocity across the stenosis is divided by the nearest normal peak systolic. A >75% stenosis is defined as a ratio of 2.5 when the peak systolic velocity across the stenosis is divided by the nearest normal peak systolic.

Depending on clinical signs and symptoms the following arteries could be included in the scan:

- Aorta
- Common iliac artery (CIA)
- External iliac artery (EIA)
- Common femoral artery (CFA)
- Proximal profunda femoris artery (PFA)
- Superficial femoral artery (SFA)
- Popliteal artery
- Tibio-peroneal trunk (TPT)
- Posterior tibial artery (PTA)
- Peroneal artery
- Anterior tibial artery (ATA)

## Reporting

- The report is a recording and interpretation of observations made during the lower limb arterial duplex ultrasound examination; it should be written by the staff member undertaking the examination and viewed as an integral part of the whole examination.
- The report should include correct patient demographics; date of examination; examination type and the name and status of the staff member.

- Reports are in the form of an annotated diagram.
- The reporting should include; which arteries have been assessed commenting on the presence/absence of flow, the anatomical position of any occlusions or stenosis, the anatomical position and size of any aneurysms, any limitations e.g. difficult examination due to body habitus.
- In the presence of a stenosis the maximum velocity within the stenosis should be noted.
  - Ensure appropriate efficient referral of critical ultrasound results to the referring consultant are made prior to the patient being

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discharged so treatment plans can be enforced or expedited accordingly.

- Critical results must be verbally communicated to the on-call specialist registrar/consultant on the day of the test. Evidence of this communication should be noted on CRIS using auto report code DVASC2.
  - Critical results can be defined as:
    - o A diagnosis of an acute arterial occlusion.
    - o Patient that describes rest pain
    - o An undiagnosed abdominal aortic aneurysm measuring more than 5.5cm in the AP plane.
    - o A pseudoaneurysm
- Unexpected results must be verbally communicated to the on-call specialist registrar/consultant on the day of the test. Evidence of this communication should be noted on CRIS using auto report code DVASC3
- All reports will be available on IMPAX within 24hrs of the scan being performed.
- Reports can be amended or removed by contacting the PACS team.

### Quality Assurance

- Equipment is purchased in line with the Trust Procurement Policy • Scanners are serviced in accordance with manufactures recommendation.
- Equipment faults are reported on the same day to medical engineering. • Staff will perform test under supervision until they have been signed off as competent by a senior member of staff.

### Monitoring

- Equipment is checked for damage on a weekly basis. Any damage is reported to medical engineers.
- Staff will have competency checked against the SOP on a quarterly basis by a senior member of staff.
  - Lower limb arterial duplex will be audited against angiography • Stakeholder feedback is obtained bi-annually through the Vascular Laboratory feedback questionnaire



## Resources:

Society for Vascular Ultrasound Vascular Technology Professional Performance Guidelines Lower Limb Extremity Venous Duplex Evaluation 2011 [www.svunet.org](http://www.svunet.org)

American Institute of Ultrasound in Medicine Practice Guideline for the Performance of Peripheral Venous Ultrasound Examinations 2010 [www.aium.org](http://www.aium.org)

Australasian Society for Ultrasound in Medicine Policies and Statements D20 Peripheral Venous Ultrasound 2007 [www.asum.com.au](http://www.asum.com.au)

## References:

1. Standards for Ultrasound Equipment Royal College of Radiologists, February 2005 [www.rcr.ac.uk](http://www.rcr.ac.uk)
2. Guidelines for Professional Working Standards Ultrasound Practice United Kingdom Association of Sonographers (UKAS) October 2008 [www.sor.org/learning/document-library](http://www.sor.org/learning/document-library)
3. The Causes of Musculoskeletal Injury Amongst Sonographers in the UK Society of Radiographers, June 2002 [www.sor.org/learning/document-library](http://www.sor.org/learning/document-library)
4. Society for Vascular Technology Professional Standards Committee Chaperone Guidelines April 2012 [www.svtgbi.org.uk](http://www.svtgbi.org.uk)