



# Baptist Cardiac & Vascular Institute

## Peripheral Vascular Laboratory

Baptist Hospital of Miami  
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### Diagnostic Criteria for Lower Extremities Arterial Duplex Evaluation

- **Normal vessel** will show no flow disturbance, absence of increased flow velocities when compared to a proximal segment and complete wall to wall color filling on Color Doppler examination.
- Greater than 50% arterial stenosis:
  - PSV > 200 cm/sec
  - Flow disturbances compared to a normal proximal segment
  - Absence of the normal triphasic Doppler signal
- Severe Stenosis:
  - PSV > 400 cm/sec
  - Flow disturbances compared to a normal proximal segment
  - Absence of the normal triphasic Doppler signal
- Arterial occlusion:
  - No flow signal visualized on Color and Spectral Doppler
- Flow Velocity Ratio: is calculated by measuring PSV at the area of stenosis and PSV obtained from a normal proximal segment.
  - 0 - 29% stenosis: < 1.5
  - 30 - 49% stenosis: 1.5 - 2.0
  - 50 - 74% stenosis: 2.0 - 4.0
  - > 75 stenosis: > 4.0
- Bypass Graft stenosis:
  - PSV ratio of 3.0 or greater at the anastomotic sites as well as from one segment to the next within the body of the graft.
  - ABI reduction to 0.15 or less.
  - PSV of 45 cm/sec or less within the body of the graft



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## Diagnostic Criteria for Lower Extremities Venous Duplex Evaluation

- Normal veins of the lower extremities are compressible with **spontaneous and phasic** flow directed **distal to proximal and superficial into deep**.
- Venous flow **increases** with the compression of tissue distal to the site of Doppler sampling and **decreases** and/or stops with tissue compression proximal to the site of the Doppler sampling.
- **Loss of phasicity** in a segment of the vein is suggestive of **proximal obstruction** and/or occlusion of a venous segment. On the other hand, the presence of a pulsatile venous signal in the lower extremity veins is indicative of **systemic venous hypertension** and/or possible **CHF**.
- **In Acute Deep Venous Thrombosis non-compressibility of the is noted and one or more of the following will be present:**
  1. Partial compressibility with the presence of thrombus.
  2. Hypoechoic filling defect.
  3. Doppler Interrogation:
    - No phasicity noted.
    - Reduced phasicity when compared to the contralateral side.
    - No or reduced flow augmentation with distal tissue compression.
    - No spontaneity with the presence of a hypoechoic thrombus.
    - No spontaneity in a patent vessel (more proximal obstruction).
- **In Chronic Deep Venous Thrombosis one or more of the following will be present:**
  1. Partial compressibility with bright intra-luminal echoes.
  2. Bright irregular venous wall.
  3. Re-canalized flow pattern
  4. Doppler Interrogation:
    - Phasicity may be normal or reduced.
    - Augmentation may be present with re-canalization.
    - Venous reflux is may be present in re-canalized segments.

- Superficial veins must be compressible and patent with no venous thrombosis and **minimal diameter of 2 mm** to be considered a **good conduit for a bypass grafts**.
- For those patient examined for Superficial Venous Insufficiency, superficial veins must be examined while patient is standing and color flow and spectral Doppler signal must document flow reflux that last > 0.5 seconds. Superficial Venous Insufficiency is graded as follows:

Degree of Insufficiency	Length of Doppler reflux signal in seconds
Grade I	0.5 - 2.0
Grade II	2.0 - 3.0
Grade III	3.0 - 6.0
Grade IV	Continuous reversal flow throughout until patient stops the Valsalva's Maneuver.



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## Diagnostic Criteria for Upper Extremities Venous Duplex Evaluation

- Normal veins of the upper extremities are compressible with **spontaneous and pulsatile flow in the proximal veins (Brachio-cephalic, Jugular and Subclavian) and spontaneous and phasic flow in the distal veins (Distal Subclavian, Axillary, Brachial, Radial and Ulnar, Cephalic and Basilic)**. Flow is directed **distal to proximal and superficial into deep**.
- Venous flow **increases** with the compression of tissue distal to the site of Doppler sampling and **decreases** and/or stops with tissue compression proximal to the site of the Doppler sampling.
- **Loss of phasicity and/or Pulsatility** in a segment of the vein is suggestive of **proximal obstruction** and/or occlusion of a venous segment.
- **In Acute Venous Thrombosis non-compressibility of the vein is noted and one or more of the following will be present:**
  1. Partial compressibility with the presence of thrombus.
  2. Hypoechoic filling defect.
  3. Doppler Interrogation:
    - No phasicity and/or no pulsatility noted.
    - Reduced phasicity and/or pulsatility when compared to the contralateral side.
    - No or reduced flow augmentation with distal tissue compression.
    - No spontaneity with the presence of a hypoechoic thrombus.
    - No spontaneity in a patent vessel (more proximal obstruction).
- **In Chronic Venous Thrombosis one or more of the following will be present:**
  1. Partial compressibility with bright intra-luminal echoes.
  2. Bright irregular venous wall.
  3. Re-canalized flow pattern may be noted.
  4. Doppler Interrogation:
    - Phasicity and pulsatility may be normal or reduced.
    - Augmentation may be present with re-canalization.
    - Venous reflux is may be present in re-canalized segments.
- Superficial veins must be compressible and patent with no venous thrombosis and **minimal diameter of 2 mm** to be considered a **good conduit for a bypass grafts, dialysis access grafts and/or AFV**.



## Diagnostic Criteria for Physiological Upper Extremities Arterial Exam

- Abnormal PVR waveforms and reduced pressures at the above elbow arm segments are suggestive of subclavian and/or axillary arterial occlusive disease.
- Wrist / Brachial systolic pressure ratio is usually **1.0 or greater**. Abnormalities at the below elbow and wrist segments are suggestive of brachial and radial / ulnar arterial occlusive disease respectively.
- Digital PPG waveforms and blood pressures are part of the digital examination. Digital pressures are normally of **20-30 mmHg of brachial systolic pressures**.
- Fingers to brachial systolic pressure ratio is normally within **0.80**
- Normal digital waveforms **acceleration** is normally lesser than **0.2 second**.
- Obstructive waveforms have a slower acceleration. Waveforms in patients with vasospasm often have abnormal shape (*Peaked Pulse*) have thought to represent abnormal vessel elasticity.
  
- When testing for **Cold Sensitivity**, the exam is performed before and after submersing the patient hands in ice water. Normal individuals have a **recovery time** to the pre-submersion values of lesser than **10 minutes**. The test is very sensitive for detecting cold induced vasospasm.
  
- For those patients tested for **Thoracic Outlet Syndrome**, the examination is performed at arm positioned at 90 degrees, 180 degrees, military brace, head turned to the right and to the left positions. Marked reduction or flattening of the PPG digital waveforms is suggestive of positive examination.
  
- Patients tested for **digital ischemia** after the creation of a **Dialysis Access**, a marked reduction or flattening of PPG waveforms amplitude when compared to the healthy arm with **drop in digital pressure to a level equal to or lesser than 60 mmHg** is suggestive of arterial steal. To confirm the test findings, compression of the access is performed while monitoring the PPG waveforms to become closer to the normal healthy arm levels.



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### Diagnostic Criteria for Physiological Lower Extremities Arterial Exam

- No brachial pressure gradient is noted. The presence of brachial pressure gradient is suggestive of an arterial occlusive disease in the proximal arteries most commonly the subclavian.
- Pulsatile signal must be noted at all level down to the metatarsal segment bilaterally. Absent pulsatility is suggestive of severe arterial occlusive disease.
- Fast acceleration of systolic peak and the presence of a dicrotic notch are normal characteristics of PVR waveforms.
- Dicrotic notch must be present on the diastolic limb of the PVR waveforms for a normal healthy artery. Absence of the dicrotic notch is suggestive of a non-compliant artery.
- At least a **50% increase** in the amplitude of PVR waveforms between low thigh and below knee with the below knee signal is higher. No increase or decrease in PVR waveforms amplitude between low thigh and below knee suggestive of femoro-popliteal arterial occlusive disease.
- Segmental pressures increases distally with an **ABI of 1.0** with no pressure gradient noted between the brachial and high thigh and/or any distal segment.
- High-thigh systolic pressure is normally **30-40 mmHg > brachial systolic** pressure with **high pressure index of 1.2 or greater**.
- The presence of pressure gradient of **20 mmHg** or greater from one segment to the distal segment is suggestive of an arterial occlusive disease to where the lower pressure obtained.
- **Normal ABI = 1.0 or greater**
- **ABI of 0.7 - 0.89** suggestive of **mild** arterial occlusive disease.
- **ABI of 0.4 - 0.69** suggestive of **moderate** arterial occlusive disease.
- **ABI lesser than 0.4** suggestive of **severe** arterial occlusive disease.
- ABI values usually increase after patient is exercised.
- ABI reduction between **15 - 50 %** after exercise suggests **moderate** arterial occlusive disease.
- ABI reduction **greater than 50%** after exercise suggests **severe multi-segmental** arterial occlusive disease.
- Toe systolic pressure is normally 80-90 % of that of the brachial systolic pressure.
- Severely reduced toe PVR waveforms and toe pressures value of lesser than **60 mmHg** are suggestive of an embolic arterial occlusive toe disease if obtained only in one digit and severe arterial occlusive disease if noted in all digits.



## Diagnostic Criteria Abdominal Duplex Evaluation

### Normal Duplex Criteria for Splanchnic Arteries:

- SMA and IMA (when identified) have a high resistance flow pattern in a fasting patient due to the relatively high capillary bed resistance. This pattern usually changes after meals (30-90 min.) during which the capillary beds are wide open and flow pattern will be noted of low resistance form.
- In a normal or mildly obstructed (<60%) SMA, peak systolic velocity is < 275 cm/sec, and end-diastolic flow velocity is < 40 cm/sec.
- Occlusion of the SMA is diagnosed by ultrasound when blood flow is absent in a portion of the vessel during color or spectral Doppler evaluation.
- Celiac artery flow pattern demonstrates low resistance form because the majority of flow volume is directed to the liver and spleen where capillary beds are wide open with or without food ingestion.  
In a normal or mildly obstructed (<60%) Celiac artery, peak systolic flow velocity is < 200 cm/sec with an end-diastolic flow velocity of < 50 cm/sec.

### Normal Duplex Ultrasonography Criteria used in Portal Venous Evaluation:

- Portal vein diameter of < 13 mm in quiet respiration, and maximum of 16 mm in during deep inspiration.
- 20 – 100 % increases in diameter of the portal, superior mesenteric and splenic veins are noted from quiet to deep inspiration.
- Portal veins flow is hepatopedal (towards the liver) throughout the cardiac cycle with mean flow velocity of 15 – 20 cm/sec.
- Maximum dimension of the spleen is usually 13 cm measured at the coronal plane.
- Congestive index (portal vein area / portal flow velocity) does not exceed 0.7.

### Duplex Criteria used in the diagnosis of Portal Hypertension:

- Portal vein diameter of > 16 mm in quiet respiration.
- No change or < 20 – 100% increase in the diameter of the portal, splenic and superior mesenteric veins from quiet to deep respiration.
- Hepatofugal (out of the liver) portal vein flow with mean flow velocity < 10 cm/sec.
- Congestive index of > 0.7.
- Enlarged spleen > 13 cm and clearly identified portosystemic collateral shunts as secondary findings.

### **Normal TIPS Duplex Evaluation Criteria:**

- Color flow Doppler in the stent must be documented wall to wall, and monophasic, slightly pulsatile continuous flow is noted.
- The direction of flow must be documented and normally seen from the portal to the hepatic ends of the shunt.
- Peak flow velocity in the shunt is normally of the range of 90 – 120 cm/sec. Flow velocity must be documented at least in 3 locations within the shunt and at the ends in the portal and the hepatic veins.
- Portal vein must be evaluated for patency, flow direction and flow velocity. An increase in flow velocity in the portal vein from the pre-procedure evaluation must be noted in normal patent shunts. Flow velocities noted post-procedure is usually in the range of 40 – 50 cm/sec.

### **Abnormal TIPS Duplex Evaluation Findings may include:**

- Localized high flow velocity and flow turbulence
- Increase in flow velocity from one point to another by  $> 100$  cm/sec
- Visible diffuse narrowing with or without high velocity
- Generalized non-pulsatile low flow velocity throughout the shunt (50 cm/sec)
- Reduced portal vein flow velocity from the pre-procedure values
- Portal vein flow velocity of  $< 30$  cm/sec
- Hepatofugal and/or to-and-fro portal and splenic venous flow

### **Duplex Criteria used to evaluate Normal Renal Artery Flow**

- Peak systolic flow velocities of 180 cm/sec or less
- Renal artery / aorta ratio of 3.5 or less
- Acceleration time of 0.07 sec or less
- Acceleration index of 300 cm/sec or greater

### **Abnormal Duplex Findings suggestive of $> 60\%$ Renal Artery Stenosis**

- Peak systolic flow velocities  $> 200$  cm/sec
- Renal artery / aorta ratio  $> 3.5$
- Acceleration time  $> 0.07$  sec
- Acceleration index  $< 300$  cm/sec
- Unilateral elevation in the pulsatility index  $> 0.7$  in the affected side
- Pulsus tardus and parvus changes in the intra-renal Doppler waveforms
- Elevated resistivity index may be noted as well, but not specific for RAS

### **Criteria used in the diagnosis of Renal Artery Occlusion include:**

- Absence of visible flow in the main artery
- Markedly reduced kidney size ( $< 9$  cm in length)
- Absence of detectable blood flow or very low amplitude intra-renal flow signal



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- Arterial occlusion:
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- Flow Velocity Ratio: is calculated by measuring PSV at the area of stenosis and PSV obtained from a normal proximal segment.
  - 0 - 29% stenosis: < 1.5
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  - > 75 stenosis: > 4.0
- Bypass Graft stenosis:
  - PSV ratio of 3.0 or greater at the anastomotic sites as well as from one segment to the next within the body of the graft.
  - ABI reduction to 0.15 or less.
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## Diagnostic Criteria for Transcranial Cerebrovascular Duplex Evaluation

- **Normal Flow Velocities and Depth Identification:**

Arterial Segment	Range Depth mm	MEAN flow velocity cm/sec	PI
MCA - M1	50	35 - 80	0.80 - 1.20
Carotid Siphon - C2	70	40 - 60	0.80 - 1.20
Carotid Siphon - C4	70	45 - 70	0.80 - 1.20
ACA	70	35 - 60	0.80 - 1.20
PCA - P1	75	30 - 50	0.80 - 1.20
PCA - P2	65	30 - 50	0.80 - 1.20
Extradural Distal Vertebral	50	25 - 55	0.80 - 1.20
Intradural Distal Vertebral	70	35 - 60	0.80 - 1.20
Basilar Trunk	95	25 - 60	0.80 - 1.20
Ophthalmic	45	20 - 40	0.80 - 1.20
Submandibular ICA - C6	60	30 - 55	0.80 - 1.20

\* A 20% increase in the MEAN flow velocity compared to the contralateral side is considered stenosis.

\* Low flow velocities globally may be seen due to diminished cardiac output, however high flow velocities globally may be seen in cases of Fever, Hypercalemia or Anemia.

- **In cases of Micro-vascular Disease:** Lower mean and elevated PI to > 1.3 - 1.6
- **In cases of Vasculitis:** Bilateral elevation in the mean flow velocities and PI's.
- **In cases of Migraine:** An increase in the mean flow velocities during an episode is noted.
- **Pulsatility and Pulsatility Index:** Refers to the relationship existing between the Cardiac Output (arterial Inflow) and the Peripheral Resistance.

Normal PI values	Increased PI	Reduced PI
0.80 - 1.20	<ul style="list-style-type: none"> <li>- Diffuse intracranial disease.</li> <li>- Micro-vascular Disease.</li> <li>- Head Trauma</li> <li>- Intracranial Bleeds.</li> </ul>	<ul style="list-style-type: none"> <li>- Proximal Carotid Artery stenosis or occlusion with ipsilateral low flow state in MCA.</li> <li>- Distal to an area of stenosis.</li> <li>- Loss of autoregulation.</li> <li>- Vasospasm, AVM with increased velocities in the contralateral vessels.</li> </ul>

- **Elevated Intracranial Pressures:**

<b>Early</b>	<b>Loss of autoregulation, PI = 0.30 - 0.60</b>
<b>Middle</b>	Mild peripheral resistance, PI = 1.50
<b>Moderate</b>	Moderate peripheral resistance, PI = 3.0
<b>Severe</b>	High resistance, loss of diastolic flow, PI = 6.0
<b>Flow reversal</b>	PI = 10

- **Vasospasm Monitoring Criteria:**

<b>Arterial Segment</b>	<b>Degree of Disease</b>	<b>Mean Flow Velocity cm/sec</b>
<b>MCA</b>	Normal	30 - 80
	Borderline	80 - 120
	Mild	120 - 150
	Moderate	150 - 200
	Severe	> 200
<b>Basilar</b>	Severe	> 160

\* Serial studies and side to side comparison may be beneficial in the diagnosis of vasospasm.



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## Interpretation Criteria for Dialysis Access Grafts and AVF's

### Normal Findings

- Flow velocity within the dialysis access grafts and fistulae are hyperdynamic in nature.
- Peak systolic velocity measurements are usually high in the range of 100 – 400 cm/sec.
- Flow pattern is of low resistance with high diastolic flow velocity in the range of 60 – 200 cm/sec.
- Flow volume is usually in the range of 400 – 1600 ml/min.
- Uniform diameter within the access graft/vein should be noted throughout without evidence of any extrinsic masses and/or aneurysmal dilatation.
- No or very minimal intimal hyperplasia should be seen as well.

Flow Pattern	Within the graft and AVF is Hyperdynamic in nature with low resistance
PSV	Usually high in the range of 100 - 400 cm/sec
EDV	Usually high in the range of 60 - 200 cm/sec
Diameter	Uniform diameter throughout the access graft / vein without evidence of any extrinsic masses and/or aneurysmal dilatation
Intimal Hyperplasia	None or very minimal

### Abnormal Findings:

- Absence of flow in the graft or access vein on color and spectral Doppler during duplex examination with high resistance flow pattern in the inflow artery and absence of pulsatility in the outflow vein are all suggestive of access occlusion.
- **For Dialysis Access Graft stenosis:**
  1. **Mild stenosis** is suspected when there is a focal increase in flow velocity within the body of the graft by lesser than 50% from one segment to the next with flow turbulence noted distal to the stenotic segment.
  2. **Moderate stenosis** is suspected if the increase in flow velocity within the body of the graft is 50 - 99% from one segment to the next with flow turbulence noted distal to the stenotic segment.
  3. **Severe stenosis** (hemodynamically significant with **> 50% diameter reduction**) is diagnosed if there is a 100% or greater increase in flow velocity from one segment to the next with the presence of flow turbulence distal to the stenotic segment.

Normal	No significant increase in flow velocity from one segment to the next
Mild Stenosis	Significant increase in flow velocity from one segment to the next by < 50%
Moderate Stenosis	51 - 99 % increase in flow velocity from one segment to the next
Severe Stenosis	100 % or greater increase in flow velocity from one segment to the next

- **For Access Fistula stenosis:**

1. Flow velocities of greater than 400 cm/sec with the presence of stenotic fistula/inflow artery ratio of 3.0 or greater indicate > 50% stenosis.
2. Access vein/outflow vein flow velocity ratio of 3.0 or greater indicates outflow stenosis of > 50%.

<b>Flow Velocity</b>	> 400 cm/sec
<b>Flow Ratio</b>	> 3.0 Velocity ratio between the AVF and the inflow artery or the access vein and outflow (central) vein

- **For graft/fistula flow volume (ml/min):**

1. 500 – 2000 indicate normal volume.
2. < 300 indicates access failure and poor dialysis.
3. 2000 may predispose patient to venous hypertension and possible congestive heart failure.

<b>Normal</b>	500 - 2000 ml/min , Calculated in the machine by using advanced measurement feature
<b>Compromised Graft with Poor Dialysis</b>	=/< 300 ml/min , Calculated in the machine by using advanced measurement feature
<b>Venous Hypertension and Possible CHF</b>	2000 ml/min or greater, Calculated in the machine by using advanced measurement feature

\* Arterial steal is suggested when a marked reduction (>50%) in the PPG waveforms pulsatility and amplitude is noted when compared to the opposite limb with digital pressure of 60 mmHg or less in the limb used for the dialysis access.



## Internal Carotid Artery Criteria for Narrowing Classification

### 0-39 % Narrowing

Peak Systolic Velocity cm/sec	End-Diastolic Velocity cm/sec	Flow Characteristics
< 125	< 50	Minimal or no Spectral Broadening

\* Not presently shown to be clinically significant in an asymptomatic patient.

### 40-59 % Narrowing

Peak Systolic Velocity cm/sec	End-Diastolic Velocity cm/sec	Flow Characteristics
125 - 199	50 - 99	Increased spectral broadening until the whole systolic window is filled

\* Not presently shown to be clinically significant in an asymptomatic patient.

### 60 - 79 % % Narrowing

Peak Systolic Velocity cm/sec	End-Diastolic Velocity cm/sec	Flow Characteristics
200 - 300	100 - 139	Marked spectral broadening

\* Considered hemodynamically significant stenosis. Clinical correlation is required.

### 80 - 99 % % Narrowing

Peak Systolic Velocity cm/sec	End-Diastolic Velocity cm/sec	Flow Characteristics
> 300	> 140	Marked spectral broadening

\* Considered hemodynamically significant severe to critical stenosis. Clinical correlation is required.

### Total Occlusion

No flow in an adequately visualized ICA with absent of the diastolic flow component in the CCA. Thumping signal may be noted at the origin of the occlusion.



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### **Normal Transcranial Imaging**

Transcranial Duplex Imaging was performed on the anterior, middle and terminal internal carotid arteries. The posterior circulation including the basilar and both vertebral arteries are also visualized. There was no increased in flow velocities with normal directional flow.

**Impression:**

Normal Transcranial Duplex Imaging study.

### **Normal Carotid Duplex Imaging (No Plaque)**

Findings by color duplex scanning indicate no evidence of plaque formation with no hemodynamically significant stenosis. Normal Extracranial cerebrovascular circulation. The vertebral arteries have forward (antegrade) flow bilaterally.

**Impression:**

No hemodynamically significant stenosis in the extracranial cerebrovascular circulation.

### **Normal Carotid Duplex Imaging (With Plaque)**

Findings by color duplex scanning indicate minimal homogeneous plaque with no hemodynamically significant stenosis in the extracranial cerebrovascular circulation. The vertebral arteries have forward (antegrade) flow bilaterally.

**Impression:**

No hemodynamically significant stenosis in the extracranial cerebrovascular circulation.





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### **Normal Lower Extremities Arterial Evaluation (at rest)**

Ankle pressures, common femoral Doppler signals and segmental pulse volume recordings were performed at rest. Ankle/brachial indices are at or greater than 0.90 bilaterally. Common femoral Doppler signals are triphasic bilaterally. Pulse volume recordings are normal with augmentation from the thigh to the calf level bilaterally.

**Impression:**

Normal arterial study of the lower extremities at rest.

### **Normal Lower Extremities Arterial Evaluation (with exercise)**

Ankle pressures, common femoral Doppler signals and segmental pulse volume recordings were performed at rest. After exercise, ankle pressures and pulse volume recordings were repeated. Ankle/brachial indices at rest and post exercise are at or greater than 0.90 bilaterally. Common femoral Doppler signals are triphasic bilaterally. Pulse volume recordings are normal with augmentation from the thigh to the calf level bilaterally. Ankle waveforms are normal after exercise.

**Impression:**

Normal arterial study of the lower extremities at rest and after exercise.

### **Normal Upper Extremities Arterial Evaluation**

Pulsatile symmetrical pulse volume recording waveforms were obtained at the upper arm, proximal and distal forearm bilaterally. Waveforms pattern and amplitude are within normal limits. Segmental pressures were obtained at the level of brachial, radial and ulnar arteries. No pressure gradient was documented bilaterally. Brachial/radial and brachial/ulnar indices are within normal value.

**Impression:**

Findings are consistent with the absence of arterial occlusive disease bilaterally.



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### **Normal Lower Extremities Venous Evaluation**

Color Duplex Imaging indicates no evidence of deep vein or saphenous vein thrombosis. The common femoral, femoral, popliteal and calf (posterior tibial and peroneal) veins as well as the greater saphenous vein are patent with no visible thrombus and with normal venous compression. All flow characteristics are normal by duplex including phasicity and augmentation with distal compression without evidence of venous reflux.

**Impression:**

No evidence of deep vein thrombosis, saphenous vein thrombosis or venous reflux bilaterally.

### **Normal Unilateral Lower Extremities Venous Evaluation**

Color Duplex Imaging indicates no evidence of deep vein or saphenous vein thrombosis. The common femoral, femoral, popliteal and calf (posterior tibial and peroneal) veins as well as the greater saphenous vein are patent with no visible thrombus and with normal venous compression. All flow characteristics are normal by duplex including phasicity and augmentation with distal compression without evidence of venous reflux. The contralateral common femoral and proximal femoral veins were examined with no visible thrombus and normal flow characteristics including phasicity and augmentation.

**Impression:**

No evidence of deep vein thrombosis, saphenous vein thrombosis or venous reflux.



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### Normal Upper Extremities Venous Evaluation

Color Duplex Imaging indicates no evidence of deep vein or superficial vein thrombosis. The jugular, brachiocephalic, subclavian, axillary, brachial, radial, ulnar, cephalic and basilic veins are all patent with no visible thrombus and with normal venous compression. All flow characteristics are normal by duplex including phasicity and augmentation with distal compression.

**Impression:**

No evidence of deep or superficial vein thrombosis bilaterally.

### Normal Unilateral Upper Extremities Venous Evaluation

Color Duplex Imaging indicates no evidence of deep vein or superficial vein thrombosis. The jugular, brachiocephalic, subclavian, axillary, brachial, radial, ulnar, cephalic and basilic veins are all patent with no visible thrombus and with normal venous compression. All flow characteristics are normal by duplex including phasicity and augmentation with distal compression. The contralateral jugular, brachiocephalic and proximal portion of the subclavian vein veins were all examined as well with no visible thrombus and normal flow characteristics including phasicity and augmentation.

**Impression:**

No evidence of deep or superficial vein thrombosis.



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### Normal Renal Duplex Evaluation

Ultrasound Duplex Evaluation of both kidney was performed with longitudinal, transverse and coronal views obtained as well as Doppler flow velocities from both renal arteries and aorta. Kidney size and echogenic pattern is within normal limits and no evidence of renal masses is noted bilaterally. Doppler flow waveforms, flow velocities and resistive indices as well as renal artery/aortic ratio are all within normal limits bilaterally. No evidence of renal artery stenosis is noted bilaterally.

**Impression:**

Normal renal duplex evaluation bilaterally.