

Vascular Ultrasound-

A Closer Look at Duplex & Physiologic Studies

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Disclaimer:

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Agenda

- Introduction
- Duplex Studies
- Noninvasive Physiologic Testing
- Other Studies
- Medical Necessity & Coverage
- Clinical Examples

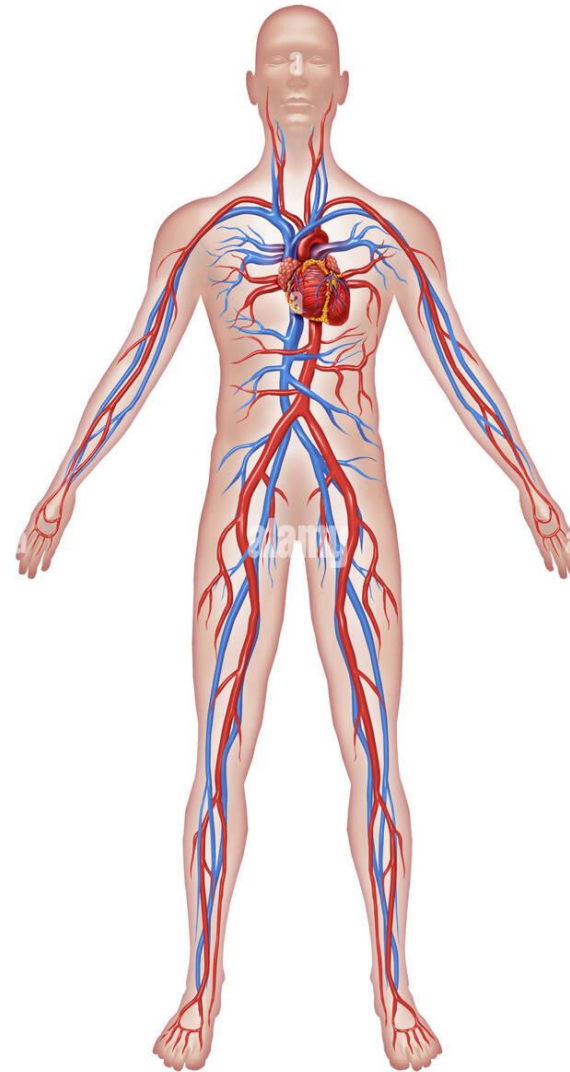
Sources/References



Vascular Ultrasound

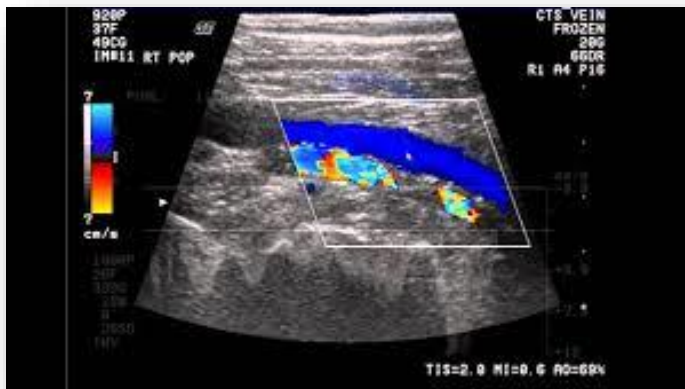
- What is Vascular Ultrasound?
- Types of Vascular Ultrasound:
 - Duplex Studies
 - Noninvasive Physiologic Studies (NPS)
- Per CPT, the Doppler unit must:
 - Produce hard copy output
 - Allow bidirectional blood flow analysis.
 - ❖ *The use of hand-held or other Doppler device that does not have these capabilities is not separately reported.*

Anatomy



Duplex Studies

- Terminology:
 - B-mode: 2D ultrasound imaging
 - Doppler: High-frequency sound waves to evaluate vessels
 - Color Flow: Color image of the vessel combined with B-mode image
 - Spectral Analysis-graphical representation of blood flow
 - Duplex: Combines Doppler with color flow and imaging



Duplex Studies

- US imaging study for evaluation of the pattern and direction of blood flow in arteries and veins
- Includes conventional ultrasound and two different types of Doppler ultrasound
 - Conventional US=2D/B-Mode
 - Doppler= Spectral Doppler AND Color Doppler

Duplex Studies

- Common Duplex Studies:
 - Extracranial/Carotid
 - Upper Extremity Arterial
 - Lower Extremity Arterial
 - Upper/Lower Extremity Venous
 - Abdomen/Pelvis Vasculature

Duplex Documentation

- A duplex scan requires production of “real time images integrating B-mode 2D vascular structure, Doppler spectral analysis, and color flow Doppler imaging”
- The report must also include documentation in the findings related to the vasculature

Per the AMA, all three components must be performed and documented in order to report a duplex scan. Without documentation of spectral analysis, it does not qualify as a Duplex scan and it would be inappropriate to report a Duplex code.

Duplex Documentation

Spectral Supporting Terminology

Analog velocity Pulsatility Bandwidth broadening Resistive index Duplex Doppler	Spectral analysis Spectral broadening Spectral Doppler Peak systolic velocity Spectral Doppler Phasicity	Tardus parvus waveforms Power Doppler Triphasic Pulsed Doppler Velocity Monophasic/Triphasic
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- *ACR Ultrasound Coding User's Guide*

Arterial Duplex-Extracranial/Carotid

CPT	DESCRIPTION
93880	Duplex scan of extracranial arteries; complete bilateral study
93882	Duplex scan of extracranial arteries; unilateral or limited study

- Performed to evaluate for carotid stenosis

Arterial Duplex-Upper Extremity

CPT	DESCRIPTION
93930	Duplex scan of upper extremity arteries or arterial bypass grafts; complete bilateral study
93931	Duplex scan of upper extremity arteries or arterial bypass grafts; unilateral or limited study

Arterial Duplex-Lower Extremity

CPT	DESCRIPTION
93925	Duplex scan of lower extremity arteries or arterial bypass grafts; complete bilateral study
93926	Duplex scan of lower extremity arteries or arterial bypass grafts; unilateral or limited stud

Venous Duplex-Upper/Lower Extremity

CPT	DESCRIPTION
93970	Duplex scan of extremity veins including responses to compression and other maneuvers; complete bilateral study
93971	Duplex scan of extremity veins including responses to compression and other maneuvers; unilateral or limited study

Abdomen/Pelvic Duplex

CPT	DESCRIPTION
93975	Duplex scan of arterial inflow and venous outflow of abdominal, pelvic, scrotal contents and/or retroperitoneal organs; complete study
93976	Duplex scan of arterial inflow and venous outflow of abdominal, pelvic, scrotal contents and/or retroperitoneal organs; limited study

- COMPLETE:
 - Arterial supply and venous drainage of an organ(s) in the abdomen and pelvis
 - Bilateral organs must BOTH be evaluated
- LIMITED:
 - Arterial only
 - Venous only
 - Unilateral

Aorta/IVC/Iliac Duplex

CPT	DESCRIPTION
93978	Duplex scan of aorta, inferior vena cava, iliac vasculature, or bypass grafts; complete study
93979	Duplex scan of aorta, inferior vena cava, iliac vasculature, or bypass grafts; unilateral or limited study

- **COMPLETE:**
 - The code is the same whether one or more vessels are evaluated.
 - The vessels investigated are studied in their entire intraabdominal or pelvic course.
- **LIMITED:**
 - Segmental or portion of the vessel
 - Follow-up studies

Duplex with Nonvascular US

- A duplex vascular ultrasound may be reported in addition to a real time ultrasound study, when both are ordered by the referring physician due to medical necessity, and both studies are performed and clearly documented with findings for both.
- Should not be coded when a “quick look” with color Doppler is done to check whether flow is present or for structure identification.
- Should not be added routinely to every ultrasound performed
- Separate report headers with associated findings are recommended
- Test Design Exception (*Clinical Examples in Radiology, Summer 2012*)
- Check CCI Edits/Payer policies

Noninvasive Physiologic Studies (NPS)

- Functional measurement procedures
- Non-imaging procedures
- Performed to diagnose vascular insufficiencies and determine severity of occlusive disease

NPS Terminology

- Ankle-brachial index (ABI):
 - Pressures are taken at the upper arm (brachial) and ankle (posterior tibial/dorsalis pedis) bilaterally to determine a measurement
 - Performed to evaluate circulation in the extremities
- Plethysmography
 - Pressures are taken at various level of the limbs
 - Performed to measure the volume of blood entering the limbs with each heartbeat and shows
 - Helps evaluate severity of arterial disease
- Oxygen Tension Measurements
 - Used to measure the local oxygen released from the capillaries through the skin
 - Helpful for wound healing predicting/hyperbaric oxygen therapy
- Provocative Functional Maneuvers
 - Examples- heel raises, cold water submersion, reactive hyperemia

NPS Extremity Arteries

CPT	DESCRIPTION
93922	Limited bilateral noninvasive physiologic studies of upper or lower extremity arteries, (eg, for lower extremity: ankle/brachial indices at distal posterior tibial and anterior tibial/dorsalis pedis arteries plus bidirectional, Doppler waveform recording and analysis at 1-2 levels, or ankle/brachial indices at distal posterior tibial and anterior tibial/dorsalis pedis arteries plus volume plethysmography at 1-2 levels, or ankle/brachial indices at distal posterior tibial and anterior tibial/dorsalis pedis arteries with, transcutaneous oxygen tension measurements at 1-2 levels)
93923	Complete bilateral noninvasive physiologic studies of upper or lower extremity arteries, 3 or more levels (eg, for lower extremity: ankle/brachial indices at distal posterior tibial and anterior tibial/dorsalis pedis arteries plus segmental blood pressure measurements with bidirectional Doppler waveform recording and analysis, at 3 or more levels, or ankle/brachial indices at distal posterior tibial and anterior tibial/dorsalis pedis arteries plus segmental volume plethysmography at 3 or more levels, or ankle/brachial indices at distal posterior tibial and anterior tibial/dorsalis pedis arteries plus segmental transcutaneous oxygen tension measurements at 3 or more level(s), or single level study with provocative functional maneuvers (eg, measurements with postural provocative tests, or measurements with reactive hyperemia)

NPS Extremity Arteries-Rest/Stress

CPT	DESCRIPTION
93924	Noninvasive physiologic studies of lower extremity arteries, at rest and following treadmill stress testing, (ie, bidirectional Doppler waveform or volume plethysmography recording and analysis at rest with ankle/brachial indices immediately after and at timed intervals following performance of a standardized protocol on a motorized treadmill plus recording of time of onset of claudication or other symptoms, maximal walking time, and time to recovery) complete bilateral study

- 93924 requires both sets of tests PLUS exercise
- Only applicable for treadmill exercise
- It is not appropriate to report code 93924 in conjunction with 93922 or 93923

NPS Extremity Arteries

LIMITED STUDY (93922): 1-2 LEVELS

Upper Extremity	Doppler Determined Systolic Pressures	<u>AND</u>	<ul style="list-style-type: none"> • Bidirectional Doppler waveform recording and analysis at 1-2 levels; OR • Volume plethysmography at 1-2 levels; OR • Transcutaneous oxygen tension measurements at 1-2 levels
Lower Extremity	ABI's at distal posterior tibial (DPT) and anterior tibial/dorsalis pedis arteries		

COMPLETE STUDY (93923): 3+ LEVELS

Upper Extremity	Doppler Determined Systolic Pressures	<u>AND</u>	<ul style="list-style-type: none"> • Bidirectional Doppler waveform recording and analysis at 3 or more levels, or at a single level with provocative functional maneuvers; OR • Volume plethysmography at 3 or more levels, or at a single level with provocative functional maneuvers; OR • Transcutaneous oxygen tension measurements at 1-2 levels, or at a single level with provocative functional maneuvers
Lower Extremity	ABI's at distal posterior tibial (DPT) and anterior tibial/dorsalis pedis arteries		

- Requires both sets of tests
- 93924 requires both sets of tests PLUS exercise

NPS Notes

- Requires two different sets of tests
- ABI's as a stand-alone procedure is not separately billable
- Noninvasive studies performed without an ABI are reported with unlisted code 93998
- If both upper and lower extremity are performed, 2 units of the NPS code may be reported
- NPS may be reported in conjunction with Duplex studies as they are on separate and distinct equipment

Other Studies

- Transcranial Doppler
- Vessel Mapping
- Less Common Duplex Studies:
 - Transcranial Doppler for vasoreactivity (93890)
 - Transcranial Doppler for emboli detection (93892-93893)
 - Penile Duplex (93980/93981)
- Unlisted (93998)

Transcranial Doppler Study

CPT	DESCRIPTION
93886	Transcranial Doppler study of the intracranial arteries; complete study
93888	Transcranial Doppler study of the intracranial arteries; limited study

- Complete TCD includes:
 - Right anterior circulation
 - Left anterior circulation
 - Posterior circulation (vertebral and basilar)
- Limited would be for unilateral, follow-up, or less than 3 territories
- Does not require color flow:
 - ❖ *“As noted in the 2022 Ultrasound Coding User’s Guide (p 35), duplex ultrasound (which requires both B-mode and Doppler Spectral analysis with color flow mapping) is not a required component of TCD codes **93886** and **93888**. Spectral Doppler analysis with or without color Doppler is sufficient; specifically, color Doppler imaging is not required.” (Clinical Examples in Radiology 2022, Volume 18, Issue 4-ERRATA)*

Hemodialysis Vessel Mapping

CPT	DESCRIPTION
93985	Duplex scan of arterial inflow and venous outflow for preoperative vessel assessment prior to creation of hemodialysis access; complete bilateral study
93986	Duplex scan of arterial inflow and venous outflow for preoperative vessel assessment prior to creation of hemodialysis access; complete unilateral study
DUPLEX OF HD ACCESS	
93990	Duplex scan of hemodialysis access (including arterial inflow, body of access and venous outflow)

- Requires arterial inflow and venous outflow

Venous Mapping

- Pre-Op for CABG procedures
- CPT 76882
- Venous mapping of the extremities (other than for dialysis access planning) or real time and color flow Doppler study of the lower extremity veins without spectral Doppler should be reported as a limited ultrasound of the lower extremity, code 76882 (*ACR Ultrasound Coding User's Guide*)

Medical Necessity & Coverage

- These studies generally have coverage limitations
- Signs & symptoms should be documented
- Common indications to monitor for education:
 - “Rule out” (DVT, stroke, carotid stenosis)
 - “Swelling” (must be more specific)

Clinical Examples

PROCEDURE: PELVIC TRANSABDOMINAL US ONLY WITH DUPLEX STUDY

CLINICAL INDICATION: Pelvic pain, R/O ovarian torsion

Comparison: No pertinent prior studies are available for comparison.

TECHNIQUE: Transabdominal pelvic ultrasound. Duplex Doppler and color Doppler evaluation of arterial inflow and venous outflow of both ovaries was performed.

DISCUSSION: UTERUS: The uterus measures 6.2 x 3.9 x 4.1 cm in length x AP diameter x and transverse width, measured transabdominally. The uterus is anteverted.

Endometrial thickness on transabdominal imaging measures 13 mm.

RIGHT OVARY: measures 3.2 x 2.1 x 2.0 cm. The right ovary appears generally unremarkable. Normal arterial and venous Doppler tracings are noted. The arterial waveform has a maximum velocity of 61 cm/s. The venous waveform has a maximum velocity of 4 cm/s...

LEFT OVARY: measures 4.0 x 1.7 x 2.0 cm. The left ovary appears generally unremarkable. Normal arterial and venous Doppler tracings are noted. The arterial waveform has a maximum velocity of 64 cm/s. The venous waveform has a maximum velocity of 6.2 cm/s.... Left hyperechoic follicle measuring 1.7 cm which may represent a hemorrhagic follicle.

There is small amount of free fluid.

IMPRESSION: 1. No evidence of ovarian torsion.
2. 1.7 cm hyperechoic left ovarian follicle which may represent a hemorrhagic follicle.

Exam Description: LE VEN DUPLX-DVT-BIL

Reason for Exam: Swelling

Procedure Note:

Deep venous evaluation both lower extremities, gray scale and color flow doppler evaluation:

History: Pain and swelling

The deep venous system within both lower extremities is patent down to the level of the popliteal veins. The visualized upper calf veins appear patent. No thrombus or Baker`s cyst is seen.

Impression: Negative bilateral study.

Please note that thrombus especially below the level of the knee cannot be totally excluded by this test and a follow up study would be suggested if clinically indicated.

BILATERAL LOWER EXTREMITY SUPERFICIAL VEIN MAPPING:

INDICATION: Pre-surgical conduit mapping for CABG procedure. Coronary atherosclerosis

Comparison: None.

TECHNIQUE: Grayscale (2D) ultrasonography was performed without and with compression. The great saphenous vein (GSV) was assessed from the saphenofemoral junction (SFJ) to the mid calf.

FINDINGS: RIGHT:

Saphenofemoral junction (SFJ): Patent with normal compression.

GSV Diameter:

Upper thigh 2.3 mm The remainder of the right great saphenous vein has previously been harvested.

Superficial venous thrombosis: None.

Venous wall thickening or calcification to suggest prior thrombophlebitis: None.

LEFT:

Saphenofemoral junction (SFJ): Patent with normal compression.

GSV Diameter:

Upper thigh 4.2 mm mid thigh 3.4 mm lower thigh 2.1 mm knee 1.9 mm upper calf 2.3 mm mid calf 2.2 mm lower calf 2.5 mm

Superficial venous thrombosis: None.

Venous wall thickening or calcification to suggest prior thrombophlebitis: None.

Additional findings: There is subcutaneous edema along the right knee/calf

IMPRESSION:

1. The upper thigh segment of the right great saphenous vein is patent. The remainder of the vein has previously been harvested.
2. The left great saphenous vein is patent.

Examination: US COLOR FLOW ARTERIAL LOWER EXTREMITY BILATERAL WITH ABI.

Comparison: RAD - Hip - 2 Views - Right RAD - Knee - 3 Views - Right

Diagnosis/REASON FOR EXAM: Peripheral vascular disease, unspecified

Additional History: LLE ulcer medial/distal. RLE ulcers posterior and lateral x 2 weeks. Injury with walker x 2 weeks ago, PVD, HTN peripheral vascular disease.

FINDINGS: ABIs:

Brachial pressures (mmHg): 175 on the right, 183 on the left.

Right ABI: 1.16 from dorsalis pedis and posterior tibial,

Left ABI: 0.64-0.68, moderately diminished (normal 0.97-1.25 mild 0.75-0.96 mod 0.50-0.74 severe < 0.5) (ABI > 1.4 can be assoc./with foot ulcers, esp. in diabetics) Pressures can be falsely elevated with vessel calcification, which is more common in diabetics.

Toe brachial indices are 0.13 on the right and 0.08 on the left, significantly diminished from normal values of 0.7. This suggests small vessel disease of the feet which is more common in diabetics.

Duplex ultrasound scanning with grayscale imaging, spectral Doppler analysis and color flow analysis performed.

Bilateral lower extremity color-flow arterial ultrasound: Diffuse calcific plaque bilaterally. Mostly monophasic waveforms bilaterally.

Left leg: Patent distal external iliac and common femoral arteries. Limited flow in the mid and distal SFA however there is diffuse shadowing plaque which partly limits evaluation. Patent anterior tibial, posterior tibial and dorsalis pedis without evidence of significant focal stenosis.

Right leg: Patent distal external iliac and common femoral arteries. Limited or no flow demonstrated through out the proximal and mid SFA with a grossly patent distal SFA. . Popliteal patent. Limited or no flow in the proximal posterior tibial with patent distal posterior tibial. Approximate 50% stenosis proximal anterior tibial. Dorsalis pedis patent. Consider correlation with CT angiography of aorta and runoff vessels as indicated.

IMPRESSION: 1. Left leg: Moderately diminished ABIs. Limited flow in the mid/distal SFA with limited evaluation due to diffuse shadowing plaque. 2. Right leg: Normal ABI. Limited or no flow in the SFA and proximal posterior tibial. Moderate anterior tibial stenosis

VASCULAR US LOWER EXTREMITY ARTERIAL DUPLEX BILATERAL W/ ABI:

Clinical: Left > Right LE abnormal ABI screening.

Comparison: None available

Procedure: Physiological testing in the form of ankle and brachial systolic pressures (ABI) are utilized in conjunction with duplex imaging of the bilateral lower extremity arterial system using gray scale sonography with color and spectral Doppler imaging.

Results:

Right Side Vel. Diam Stenosis Waveform cm/s Dist Common Femoral 98.4 Biphasic Proximal Femoral 109.0 Middle Femoral 186.0 20-49% Distal Femoral 132 Popliteal AK 85.6 Mid Popliteal 62.1 Popliteal BK 67.1 Dist Post Tibial 89.1 Biphasic Mid Peroneal 103.0 Biphasic Dist Anterior Tibial 0.0 Occluded

Left Side Vel. Diam Stenosis Waveform cm/s Dist Common Femoral 119.0 Biphasic Proximal Femoral 112.0 Middle Femoral 112.0 Distal Femoral 241 50-74% Popliteal AK 76.0 Mid Popliteal 76.0 Popliteal BK 56.0 Prox Post Tibial 49.0 Mid Post Tibial 0.0 Occluded Dist Post Tibial 109.0 Biphasic Mid Peroneal 61.0 Biphasic Dist Anterior Tibial 16.0 Biphasic

ABI Right Left (mmHg) Waveform (mmHg) Waveform Brachial 178 186 PTA 208 182 ATA 162 142 Digit 146 DBI: 0.78 148 DBI: 0.80 ABI Pre 1.12 0.98 exercise

General: ANKLE BRACHIAL INDICES Pulses bilateral ATA and PTA are absent by palpation. Ankle brachial indices are within normal limits at rest. Toe brachial indices are within normal limits.

RIGHT LOWER EXTREMITY Right lower extremity arterial duplex 20-49% stenosis mid femoral (95 - 173 cm/s); no additional segments hemodynamically significant stenosis of the extremity. Moderate-severe above knee and severe below knee calcific atherosclerosis with acoustic shadowing. Biphasic distal waveforms peroneal and posterior tibial arteries; retrograde flow distal anterior tibial artery with more proximal occlusion.

LEFT LOWER EXTREMITY Left lower extremity duplex with 20-49% stenosis prox-mid femoral (94 - 140 cm/s) and 50-74% stenosis distal femoral artery (98 - 241 cm/s). Moderate-severe above knee and severe below knee calcific atherosclerosis with acoustic shadowing. Probable proximal posterior tibial artery occlusion with distal reconstitution. Biphasic waveforms distal anterior tibial and peroneal arteries.

Conclusions: 1. Bilateral ankle brachial and toe brachial indices within normal limits at rest. 2. Right lower extremity arterial duplex without hemodynamically significant stenosis. Occluded anterior tibial artery without evidence of reconstitution. Biphasic two vessel distal run-off. 3. Left lower extremity arterial duplex 50-74% stenosis distal femoral artery with proximal posterior tibial artery occlusion and distal reconstitution. Biphasic two vessel distal run-off. 4. Severe calcific atherosclerosis small vessels with acoustic shadowing.

Procedure: US PULSE VOLUME RECORD WITH EXERCISE

Comparison: No comparisons

Diagnosis/ REASON FOR EXAM: m79.606; Pain in both lower extremities, decreased pedal pulses peripheral vascular disease.

FINDINGS: Brachial pressures (mmHg): 136 on the right, 138 on the left.

Right ABI 0.72-0.74, moderately diminished

Left ABI 0.67-0.85, mildly diminished

(normal 0.97-1.25 mild 0.75-0.96 mod 0.50-0.74 severe < 0.5)

(ABI > 1.4 can be assoc./with foot ulcers, esp. in diabetics)

Doppler waveforms (normal - multiphasic):

Right: Monophasic at the popliteal and below

Left: Monophasic at the popliteal and below

Significant segmental limb pressure gradients (>30 mmHg):

Right: Mild iliofemoral

Left: No significant

Pressures can be falsely elevated with vessel calcification, which is more common in diabetics.

Treadmill exercise testing was performed

Response to exercise from treadmill exercise testing (nl:increase in pressure):

Right: Abnormal decrease from 102 down to 72 ABI decreases from 0.74 down to 0.47.

Left: Mildly abnormal decrease from 117 down to 99 ABI decreases from 0.85 down to 0.65.

Above findings suggest possible hemodynamically significant stenotic disease of the lower extremities, worse on the right, suggested at the right iliofemoral segment and indeterminate location on the left.

Consider correlation with CT angiography as indicated.

IMPRESSION:

1. Mild-to-moderately diminished ABIs, worse on the right.

2. Abnormal response of both legs is exercise, worse on the right.

3. Findings suggest hemodynamically significant stenotic disease of the lower extremities, worse on the right, suggested at the right iliofemoral segment and indeterminate level on the left.

EXAM DESCRIPTION:
Transcranial Doppler COMPLETE

HISTORY: Subarachnoid hemorrhage. Assess for vasospasm.

Comparison: January 2, 2023

TECHNIQUE: Spectral, doppler waveform evaluation of the complete bilateral intracranial arterial structures.

FINDINGS: PEAK SYSTOLIC VELOCITY (CM / SEC):

L MCA: 147

L ACA: 147

L PCA: 69.3

L VA: 41.2

R MCA: 87.4

R ACA: 82.5

R PCA: 25.7

R VA: 45.0

BA: 29.1

LEFT LINDEGAARD RATIO: 2.85

RIGHT LINDEGAARD RATIO: 1.46

IMPRESSION:
Velocities, ratios remain below vasospasm range.



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