WHEN AND WHAT TYPES OF VASCULAR STUDIES TO ORDER

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OBJECTIVES

1. Become familiar with cost effective vascular imaging.

2. Become familiar with sensitivity and specificity of Non-Invasive Vascular Services when compared to MRA and CTA.

3. Become familiar with nationally accepted CMS recommendations for vascular studies.
NON-INVASIVE VASCULAR LAB

- **IAC VASCULAR ACCREDITED?**
  *In All Modalities*

- BOARD CERTIFIED VASCULAR AND CARDIAC SPECIALIST

- REGISTERED VASCULAR TECHNOLOGIST-RVT, RVS
STATE OF THE VASCULAR LAB

Accreditation will be a requirement by CMS in the up and coming years

- Mobile Labs***
- Office ***
- Privateers ***

*Several Vascular Studies* currently require accreditation and registration

- Arterial Duplex & Physiologic Arterial Studies
- Venous Duplex
WHY NON-INVASIVE

Advantages

- COST EFFECTIVE
- Very Sensitive and Specific
- Safe
- Gives Real Time Flow Physiology***
- Real Time Imaging
- Quick and Easy (No Tubes, Gyros, Anxiety, Moving Parts, etc...)
- Non-Invasive (No I.V’s no Dyes)
- No Radiation
- Non Limiting- (No Patient Prep (or) Very Minimal)
- Not Nephrotoxic

Disadvantages

- OPERATOR DEPENDANT
- Severe Calcification Shadowing(Limited)
- Bowel Gas
- Staples or Sutures
- Body Habitus
Remember This Slide From 2011

The NEW Healthcare.
More Government for all!

TheDailyDose.com
TYPICAL MODALITIES PERFORMED

- CAROTID DUPLEX
- VENOUS DUPLEX
- ARTERIAL PHYSIOLOGICAL
- ARTERIAL DUPLEX
- MESENTERIC DUPLEX
- RENAL DUPLEX
- PORTAL DUPLEX
- IVC Duplex
- INTRACRANIAL (Specialty)
- TRANSPLANT (Liver, Renal)
- TIPS DUPLEX
- AVF DUPLEX
- VENOUS INSUFFICIENCY DUPLEX

Most Hospitals/Ultrasound Suites

Dedicated Vascular Labs-
All Modalities (FCCI performs 31)
DUPLEX WHAT IS IT?

Duplex

COMBINATION OF MODALITIES

NOT DOPPLER ALONE ***

Real Time Imaging

• SPECTRAL DOPPLER
• COLOR DOPPLER
• 2D GREY SCALE IMAGING
Quick Note About Vascular Disease

PAD affects 12-20% of Americans age 65 and older.

Once an abdominal aortic aneurysm has ruptured, the chances of survival are low, with 80 to 90% of all ruptured aneurysms resulting in death.

AAA affects as many as 8% of people over the age of 65 Males are four times more likely to have AAA than females.

Stroke is 3rd leading cause of death in United States, behind high blood pressure and cancer.
Carotid Duplex
Carotid Duplex

Dissection

Complex Plaque
CAROTID DUPLEX

Severe Ulcerated Plaque

ICA Post Stenting
Carotid Duplex

Quickly becoming the extra-cranial first order testing

Carotid Duplex is the preferred method of follow-up after CEA and Stenting

Extracranial Carotid Duplex

What’s Included

- Common Carotid Arteries
- Internal Carotid Arteries
- External Carotid Arteries
- Vertebral Arteries
- Subclavian Arteries

*Special Cases*

- Temporal Arteries & RIMA/LIMA

Scanner
Carotid Duplex Testing

Direct Visualization
- Plaque Profiles and Composition
- Diameter Reduction
- Arterial Hemodynamics
- Anatomy and Anatomical Variations
- Graft Surveillance
- Stenting
- Carotid / Subclavian Interventions

Real Time Doppler

[Image showing Doppler waveforms and ultrasound images]
Carotid Duplex

Sensitivity and Specificity

NASCET

North American Symptomatic Carotid Endarterectomy Trial

- 99% sensitive to detect carotid disease
- 90%-95% sensitive to detect carotid stenosis 50-99%

Based on Gold Standard Cerebral Angiography

- Overall Accuracy of 88% for a 70-90% Lesion
  When NASCET Criteria is Utilized

At Risk Populations Have to Be Followed

*Asymptomatic Carotid Atherosclerosis Study (ACAS)*

**ACAS Tells us That Patients with a > 60% Asymptomatic Stenosis are at a 11% RISK of STROKE at 5yrs** (with medical management alone)

Zweibel & Pellerito, 2004, Introduction to vascular ultrasound
At Risk Populations Have to Be Followed

*Symptomatic Patients (NASCET)*

- 50%-69% stenosis  
  22% stroke at 5 yr

- >70% stenosis  
  fatal and non-fatal stroke is 24% at 18 months with medical management alone.

Zweibel & Pellerito, 2004 Introduction to vascular ultrasound
MRA vs Carotid Duplex
Carotid Artery Imaging Only***

ICA SENSITIVITY 87-95%

ICA SPECIFICITY 46-100%
MRA
Carotid Artery Imaging Only***

**PROS**
- Non Ionizing
- 3d Images of Arteries
- Not Limited by Heavy Calcification (Hardening Artifact)

**CONS**
- Expensive
- Overestimates Stenosis
- Has a varying Degree of Sensitivity ***
- Difficulty differentiating Between String and Occlusion
- Problematic with Stents****
- Patient Movement
- Relies on Laminar Flow (Signal Dropout***
MRA Typical Uses

Intracranial MRA

- As a follow-up study for a known arterio-venous malformation (AVM), and for a known non-ruptured intra-cranial aneurysm (ICA) that is greater than 3 mm in size.

- To definitively establish presence of stenosis or other abnormalities of the vertebrobasilar system in members with symptoms highly suggestive of vertebrobasilar syndrome (binocular vision loss, positional vertigo, dysarthria, dysphagia, diplopia) \(\text{(NEED INTRACRANIAL ULTRASOUND)}\).

- To evaluate members with signs/symptoms highly suggestive of leaking/ruptured ICA or AVM (i.e., sudden explosive headache, stiff neck, blood in the cerebral spinal fluid);

- To rule out ICA Siphon aneurysms of the circle of Willis,
CTA
Carotid Artery Imaging Only***

Sensitivity and Specificity of 97%-99%

When compared to the Gold Standard

CTA for Carotid Imaging vs Duplex

**PROS**
- Accurate and Reliable
- Quick- *Less Susceptible to Artifact*

**CONS**
- RADIATION & CONTRAST
- Inaccurate with *Heavily Calcified Plaques (Hardening Artifact).*
- Expensive $$$$$$$$$$$
Carotid Angiography

The Gold Standard In Arterial Imaging
Indications for Carotid Duplex

- **Stroke** (any sign and symptom) *Aphasia, Paralysis, Ataxia, Dysarthria..etc*
- **TIA**
- **Syncope** - *With or Without Collapse*
- **Visual Disturbance** (Amaurosis Fugax, Hemiaopsia)
- **Cervical Bruit**
- **Carotid Stenosis or Occlusion**
- **Dizziness** (Non-Specific)
- **Pre-Op**
- **Subclavian Steal Syndrome**
- **Fibromuscular Dysplasia (FMD)**
- **Previous Hx of CEA** (2.1% develop >80% re-stenosis within 2 years, 0.5% in 6 months)
- **Arterial Trauma** (Dissection, Pseudoaneurysm)
- **Carotid Body Tumor** (Usually an Incidental Finding)
Carotid Duplex Follow Up and CMS Recommendations

Based on Degree of Stenosis (NASCET)

REMEMBER

75 to 80% of Strokes are linked to Carotid Artery Blockage

<table>
<thead>
<tr>
<th>Degree of Stenosis</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal (1-49%)</td>
<td>Annually</td>
</tr>
<tr>
<td>Moderate (50-69%)</td>
<td>6 Months</td>
</tr>
<tr>
<td>Severe (70-99%)</td>
<td>3-6 Months</td>
</tr>
</tbody>
</table>

Post Stenting and CEA Follow-up < 6 weeks, 6 months, 12 months

Lower Extremity Physiological-Arterial Testing

PVR
Pulse Volume Record
PVR
What Does it Test

First Line of Defense *(Screening Tool)*

- Arteries of the Legs and Arms
- Thoracic Outlet Syndrome (TOS)
- Exercise Physiological Testing
- Raynaud's *(Cold Immersion Testing)*
- Palmar Arch Patency
- Allen's Test
- Digital Ischemia
- Penile (Limited)
What's Included

- Abnormal Pressures
- Volume Waveforms
- Doppler Tracings
- PPG Tracings (Infrared)

Completely Physiologic
What’s In a Report
### PVR Indications

#### Indications

- Claudication
- Limb Pain Acute/Chronic
- PVD
- Atherosclerosis
- Aneurysmal Disease Lower/Upper
- Arterial Thrombus
- Trauma
- Tissue Necrosis/Ulcer
- Blue Toe
- Cold Foot
- Pulselessness
- Raynaud's Syndrome***

#### Contraindications

- Stents & Bypass Grafts (Duplex)
- Hypertension (>200 mmHg systolic pressure)
- Uncontrolled Angina
- Chest pain of recent onset
  - Acute DVT****
  - Evidence of shortness of breath
  - Unsteadiness when walking
Upper Extremity PVR

Abnormal

Abnormal
RAYNAUD’S DISEASE

- Vasospastic Disorder
- Cold Temperatures and Stress are Triggers
Raynaud's Phenomenon

Type I (Primary)

Type II (Secondary)
Arterial Duplex

2D Grey Scale

Duplex
Arterial Duplex

Indications For Testing Are The Same As Physiologic Testing
Arterial Duplex

What’s Included

- 2D Grey Scale
- Velocity Profiles
- Plaque, Thrombus, and Pathology Presentation
- Interventional Surveillance
**Arterial Indications**

1. Claudication
2. PVD
3. PAD
4. Atherosclerosis w/ Claudication
5. Aneurysm/Pseudo Disease Lower/Upper
6. Arterial Thrombus
7. Atherosclerosis with Necrosis/Ulcer
8. Pulselessness
9. Blue Toe
10. Cold Foot
11. >20mmhg Between Brachial Pressures (subclavian stenosis)
12. ABI alone is not billable, it is considered part of the visit.

**PVR Contraindications**

- Stents & Bypass Grafts (Duplex)
- Hypertension (>200 mmHg systolic pressure)
- Uncontrolled Angina
- Chest pain of recent onset
  - Acute DVT
  - Evidence of shortness of breath
  - Unsteady Gait****

**Typical 11- In Office Indications!!!**
Arterial Duplex vs PVR

- Indications are same as Physiologic Testing
- Direct Visualization Testing
- Incorporates ABI
- Can Measures Lesion Length
- Can differential between Occlusion and Stenosis
- Can differentiate between plaque and Thrombus
- 2nd Step in Non-Invasive Arterial Imaging/ Or Primary Given Your Preference
Arterial Duplex Post-Op/Procedural Surveillance

Patients with Intervention MUST BE FOLLOWED

- Stents/Grafts = 6 Weeks, 3, month, and every 6 months thereafter.
- Or allowed anytime the patient is symptomatic
Venous Duplex

NURSE!!! I THINK YOU NEED TO CHECK MY IV LINE!!!
Incidence of DVT

Every year, an estimated 200,000 up to 600,000 Americans will suffer from deep-vein thrombosis (DVT) and pulmonary embolism (PE).

For the 60,000 to 200,000 individuals who develop PE, their condition will be fatal.

In the United States, more people die each year from PE than motor vehicle accidents, breast cancer or AIDS.
Venous Duplex

DVT

COMMON FEMORAL VEIN THROMBUS

COMMON FEMORAL VEIN THROMBOSIS
Abdomen and Upper Venous Venous

IVC with Filter

IJV with Thrombus
Lower Extremity Venous Duplex

What’s Included

DVT AND SVT ONLY

Deep Venous System Only
Calf Veins
Partial Superficial System

**DOES NOT EXAMINE VENOUS VALVES**
Upper Extremity Venous Duplex

Deep System
- IJV
- Subclavian Vein
- Brachial Vein
- Axillary Vein
- Radial Veins
- Ulnar Veins

Superficial System
- Basic Vein
- Cephalic Vein
Venous Duplex

When to Order (Upper or Lower)

ANY TIME THERE IS AN ACUTE CHANGE IN LIMB SIZE OR PAIN

ANYTIME THERE IS A CLINICAL CHANGE IN PATIENTS THAT HAVE PAST HISTORIES OF DVT
Lower Extremity Venous Duplex

Venous Duplex with 2D compression is considered the Gold Standard for Lower Extremity Deep Venous/Superficial Venous Phlebitis

Does not Include Iliac Veins (External or Common)

May need Venogram or MRV
Venous Duplex

Pros
- Cost Effective
- Very Sensitive and Specific
- Availability

Cons
- Operator Dependent
- Body Habitus
- Shadowing
- Edema
- Limb Size
- Can Be Painful
Indications
Upper, Lower, Abdominal

- Limb Swelling (Acute/Chronic)
- Limb Pain
- DVT (Acute of Chronic)
- Superficial Phlebitis
- Venous Ulcers
- Pulmonary Embolism *****
- May-Thurners Syndrome (MTS) (Right Iliac Artery Crosses Over Left Iliac Vein)
- Ulcerations
- Acute SOB
- Post Op
- Extended Inactivity/Bed Rest
- Chronic Venous Insufficiency
- Budd Chiari Syndrome
- Vena Cava Thrombus
- Portal Hypertension

- Renal Thrombus
- IJV Thrombus
- SVC Syndrome
- Upper Extremity Swelling/Pain
- Vein Mapping (AVF/ Bypass)
- IVC Filter Surveillance
- Clotting Disorders (Factor V)
- Post Major Surgery
Other Venous Modalities

**MRV**

For evaluation of thrombosis or compression by tumor of the cerebral venous sinus in members who accompanying a headache;

For evaluation of venous thrombosis or occlusion in the large systemic veins (e.g., superior vena cava, subclavian, or other deep veins in the chest)

For evaluation of venous thrombosis or occlusion in the portal and/or hepatic venous system (e.g., Budd-Chiari syndrome).

**Venogram**

Gold Standard

http://www.aetna.com/cpb/medical/data/1_99/0054.html
Venous Insufficiency

Note:

More than 25 million Americans suffer from venous reflux disease.

Gender and age are two primary risk factors in the development of venous reflux.

An estimated 72% of American women and 42% of men will experience varicose veins symptoms by the time they reach their sixties.

Women who have been pregnant more than once and people who are obese, have a family history of varicose veins or spend a great deal of time standing have an elevated risk for the condition, but it can occur in almost anyone at almost any age.
Venous Insufficiency

Signs and Symptoms
- Lim pain and fatigue in the legs
- Swollen ankles and calves
- Burning or itching skin
- Skin discoloration and leg ulcers
- In less severe cases, thin, discolored vessels – “spider veins” – may be the only symptom
Venous Insufficiency Testing

- Chronic Venous Insufficiency (CVI) is the direct cause of secondary Lymphedema

- >60% of Lymphedema patients have some sort of concomitant Venous Insufficiency
CEAP Classification

- Clinical severity
- Etiology or cause
- Anatomy
- Pathophysiology

Grade Description

- C 0 No evidence of venous disease.
- C 1 Superficial spider veins (reticular veins) only
- C 2 Simple varicose veins only
- C 3 Ankle edema of venous origin
- C 4 Skin pigmentation in the gaiter area (lipodermatosclerosis)
- C 5 A healed venous ulcer
- C 6 An open venous ulcer

http://www.simondodds.com/Venous/CEAP_classification.htm
Venous Insufficiency
Venous Insufficiency
Venous Insufficiency

**Signs and Symptoms**
- Chronic Edema
- Chronic Limb Pain or Swelling
- Lipodermatosclerosis
- Prior Ulcers
- Active Venous Ulcers
- Superficial Varices
- Spider Veins/Recticular Veins
- Lymphedema
- Restless Legs
- Failed Compression Therapy
- CEAP Classification
- Previous CABG

**Persistent Issues**
- Hx of Stripping In Past (persistent swelling)
- Pelvic Congestion
- Hx of Vein Surgery
Venous Insufficiency Testing

Specialty Test of the Lower Extremities Dedicated SOLEY to the Valvular Disorder of the Veins
Venous Insufficiency Testing

What's Included

- DVT Study
- Deep Venous Valve Surveillance
- Superficial Venous Valve Surveillance
- Perforators
- Accessory Veins
- Vein Mapping

Venous Insufficiency is Measured in Seconds

>3sec is severe
Abdominal Venous Duplex

What’s Included

- IVC
- Portal Vein
- Splenic Vein
- SMV
- Hepatic Veins
- Renal Veins
MESENTERIC DUPLEX

Vessels Insonated

Aorta Scanned for AAA
Celiac Artery
Hepatic Artery
Splenic Artery
Superior Mesenteric Artery
Inferior Mesenteric Artery
Hepatic or Portal System (Specific Testing)
Mesenteric Duplex
When To Order

**Indications**

- Mesenteric Ischemia  
  Order anytime you have
- Abdominal Bruit
- Post Prandial Abdominal Pain
- Abdominal Pain (Acute or Chronic)
- Weight Loss *(abnormal, acute or chronic)***
- Bloating (chronic)
- Diarrhea
- Acidosis (Acute)
- Post Stenting/Bypass *(Follow Every 1, 3, 6, months, then annually )*
- **MALS** *(Young Adults Mainly Female)*
MEDIAN ARCURATE LIGAMENT SYNDROME (Dunbar Syndrome)

Symptoms

- Abdominal Pain (Unexplained)
- Nausea
- Vomiting
- Weight Loss (Anorexia)

Respiration Causes Compression

http://www.vasculardiseasemanagement.com/content/a-case-median-arcuate-ligament-syndrome-successful-angioplasty-and-stenting
Mesenteric Duplex

**Sensitivity and Specificity >80%**

In the Detection of >70% Stenosis of SMA and Celiac

Zweibel & Pellerito (2004) Introduction to vascular ultrasonography
Mesenteric Ischemia

CTA Versus MRA

**CTA**
- 100% Sensitive
- 73% Specific  
  (Acute Mesenteric Ischemia)

**MRA**
- Rarely Utilized in Mesenteric Ischemia

Mesenteric Ischemia

Angiography is the Gold Standard
Limitations

- **Very Technologist Dependant**
- Obese Patients (Severe)
- Acoustic Shadowing
- Patient Compliance
- **Non Compliance** (Not NPO, Smoking)
- **Sensitivity and Specificity** (Technologist Dependant)
Renal Duplex
HYPERTENSION

RENAL ARTERY STENOSIS

About 1 in 3 U.S. adults—an estimated 68 million people—has high blood pressure and 3%-5% of this group has renal arterial disease.

Renal Duplex

INDICATIONS

- Hypertension (uncontrolled, malignant, benign, unspecified)
- Renal Artery Atherosclerosis
- FMD
- Post Procedural/Stenting
- Renal Artery Aneurysm
- Renal Chemistry (Creatine, Bun)
- Chronic or Acute Renal Failure/Insufficiency
- Renal Vein Thrombosis
- Renal Vein Tumor (IVC origin)
- Ateriovenous Fistula (usually post biopsy or transplant)
- Pseudoaneurysm (post biopsy)
- Allograft Surveillance (Renal Transplant)
- Nut Cracker Syndrome*** (Compression)
Renal Duplex

Vessels Insonated

- Aorta is Screened for AAA
- Kidney Size (Hydronephrosis, Calculi, or Masses)
- Cortical and Medullar Arteries
- Renal Veins and Arteries

Physiologic

- Resistivity Index (RI) > .80 severe
- Renal Aorta Index (RAR) > 3.5 Severe
- Acceleration Time (AT) > 1 sec Severe
Renal Duplex for Stenosis

**SENSEITIVITY AND SPECIFICITY**

Wide Ranging

Sensitivity 0-98%
Specificity 37%-99%
Renal Duplex

When to Order

- Any time the patient is hypertensive
- <60% Stenosis Yearly
- >60% 3-6 months
- Flank Bruit

Anytime blood pressure is unmanageable or elevated
Aortic Duplex
Aorta and Iliac

- 60% of aneurysms are asymptomatic, generally discovered *incidentally* during imaging scans and physical examinations.

**NOTE**

THE PHYSICAL EXAM IS ONLY 58% SENSITIVE AND 75% SPECIFIC FOR AAA > 3CM

-Zweibel & Pellerito, 2004, Introduction to vascular ultrasound
Aorta and Iliac Duplex

What’s Included

- Abdominal Aorta
- Common Iliac Arteries
- External Iliac Arteries
- SMA, Celiac
- Bilateral Renal Arteries
- Endografts
- Aortobifems
- Aortic Stents**
- Any Intervention in the Abdomen
Aorta and Iliac Duplex

Indications

- Pulsatile Abdominal Mass (Including Iliac area)
- Pulsatile Groin Mass
- Abdominal Trauma
- Hx: AAA
- Dissection
- Abdominal Bruit (may have stenosis)
- Abdominal/ Pelvic Pain (may be iliac)*****
- Claudication (mainly buttock and thigh areas)
- Hx: Aortic Stenosis
- PVD
- Family History
- Welcome to Medicare (Initial Visit)
Welcome to Medicare-AAA Screening

Effective for services furnished on or after January 1, 2007, payment may be made for a one-time ultrasound screening for AAA for beneficiaries who meet the following criteria:

(i) receives a referral for such an ultrasound screening as a result of an initial preventive physical examination

(ii) receives such ultrasound screening from a provider or supplier who is authorized to provide covered diagnostic Services

(iii) has not been previously furnished such an ultrasound screening under the Medicare Program

https://secure.codecorrect.com/knowledge/article_print.cfm?aid=137441&doctype=42
Patient has to have at least one of the following risk categories

(I) has a family history of abdominal aortic aneurysm;

(II) is a man age 65 to 75 who has smoked at least 100 cigarettes in his lifetime

(III) is a beneficiary who manifests other risk factors in a beneficiary category recommended for screening by the United States Preventive Services Task Force regarding AAA, as specified by the Secretary of Health and Human Services, through the national coverage determination
Aortic Aneurysm’s
When to Follow

On average the diameter of an AAA will grow 2-5mm per year

- <3.0 cm Yearly
- >3.5 cm every 6 months
- >5.0 cm surgical or interventional repair may be recommended

AAA measuring 4.5cm-6.0 cm have a rupture rate of 10% per year
Aorta Imaging
CTA vs Duplex

CTA
- Acute Trauma
- Acute Rupture
- Acute Dissection
- Anatomy (Pre-and-Post Intervention) **Endografts**
- Endo Leak Detection

Duplex
- Screening
- Interventional Surveillance
- Post Endograft Imaging (Sac size only)
- Non-Acute Setting***
Abdominal Incidental Findings

Gallbladder

Liver Mass
QUESTIONS

Thank you
Case Studies

Question and Answer Session

WHAT AND WHEN TO ORDER
Case 1

Patient Hx:

- 56 year old patient presents to the office with 2 blue toes.
- Patient states “that his toes have progressively gotten darker and more painful over last 3 weeks.”

NOW WHAT ??
Patient Hx:

- 39 year old new patient that presents with a brawny discoloration to Right Anterior Calf.
- The Left anterior shin area is noted with a wet active ulcer.

NOW WHAT ???
Case 3

- 65 Year old patient with a hx of diabetes, hypertension, and smokes is complaining of radiating right buttock pain at rest.

- The patient is also complaining of left buttock and thigh pain when walking to mailbox

NOW WHAT ????
Case 4

- 78 year old patient with hx of CABG x 5, 3 years ago, now presents with Dizziness, Angina, and Left Arm Pain, with exercise, but resolves with rest.

- The right brachial pressure is 125/72

NOW WHAT?
Case 5

- 22 year old male patient with 3 year hx of progressively worsening hypertension. Patient is non-smoker with a the mother having hypertension in her late 50’s

- The patient is currently on a combination of hypertensive medicine, and his blood pressure is unmanageable.

NOW WHAT ????
Case 6

- 62 year old female new patient presents with right arm pain and dizziness.
- Her right Brachial pressure is 100/80, and her left is 150/90
- Patient is a poor historian and presents with a family member who is also a poor historian.
- Patient states “she has had some sort of right neck and right arm surgery.”

**NOW WHAT????**
Furthermore

- Is ultrasound always the best modality. No! but why not start there?

- The *General* Sensitivity and Specificity of ultrasound is high. The tighter the lesion the more specific the data is.

- Keep referrals to dedicated vascular labs, and the variance of sensitivity and specificity will be lower.