Vascular Diagnostic Testing

Optimum Re
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Purpose

• To evaluate the blood flow within the arteries and veins of the lower extremities and the arteries of the upper extremities and neck
Reasons for Testing:

- Elevated lipids
- Smoking
- Hypertension
- Diabetes
- Coronary Artery Disease/CABG
- Skin Ulcers
- Leg or arm pain or swelling
- Weak/absent pulses
Vascular Diagnostic Testing

Part 1
Upper Extremities and Carotid Arteries

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Reasons for Testing

- Headaches
- Visual Disturbances
- Dizziness
- Unilateral Weakness/Numbness
- Asymptomatic bruit
- General screening
Upper Extremities

- Subclavian artery
- Axillary artery
- Brachial artery
- Innominate and forearm arteries
- Bypass grafts
Carotid Circulation
Carotid Arteries
Carotid ultrasound examination

Conventional Ultrasound

- A *transducer* creates *painless sound waves higher than the human ear can hear*.

- *Sound waves bounce off the structures they encounter*.

- *Computer converts the sound waves into 2-D black and white (“grayscale”) moving pictures called B-mode images*.

- *Shows the STRUCTURE of blood vessels*.
Carotid duplex

Ultrasound wand

Carotid artery
**IMT/CIMT**

- **Carotid intima-medial thickness**
- **Measurement of the tunica intima and the tunica media, the innermost two layers of the carotid artery**
- **Not universally accepted as an accurate determinant, but is still used for general screening**
Plaque Detection by Carotid Artery “IMT” Analysis

- Media (muscular layer of artery)
- Intima (normally thin)
- Adventitia (lining of artery)
- Plaque

Carotid Artery
IMT (Intima-medial thickness)
IMT/CIMT

- Not universally accepted as a good screening tool
- Where to take the measurement?
- Reason for the thickening?
- Generally accepted that measurements > .9-1mm are indicative of atherosclerosis
Doppler Ultrasound

- Measures how sound waves reflect off of moving objects
- A wand bounces short bursts of sound waves off of RBC’s and sends the information to a computer
- Produces 2-D color images
- Shows the MOVEMENT of the blood cells through the vessels
Color Doppler
Color Doppler
Duplex Ultrasound

- Uses the two forms of ultrasound together
- Produces images that can be color-coded to show where the blood flow is blocked along with the speed and direction of the blood flow
Benefits

- Non-invasive—usually painless
- Widely available, easy-to-use, less expensive
- Uses no ionizing radiation
- Gives pictures of soft tissues that do not show up well on x-rays
- May be repeated as often as necessary
Limitations

- Difficult or impossible if a dressing is covering a wound
- Size or contour of the neck
- Calcium deposits in the wall of the vessel may make it difficult to evaluate
- Small amount of soft plaque may go undetected
- May not clearly depict the end segment
Interpretation of Doppler US

- Should consist of results of grayscale imaging, color Doppler imaging and spectral Doppler velocity determination
- Peak systolic velocity
- % stenosis
- Doppler is not accurate in sub-categorizing lesions <50%
Interpretation—Carotid

- Normal (no stenosis)
- <50% stenosis
- 50%-69% stenosis
- >70% stenosis but less than near occlusion
- Near occlusion
- Total occlusion
PSV vs. % Stenosis*

*Society of Radiologists in Ultrasound
<table>
<thead>
<tr>
<th>Degree of Stenosis (%)</th>
<th>Primary Parameters</th>
<th>Additional Parameters</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>ICA PSV (cm/sec)</td>
<td>Plaque Estimate (%)*</td>
</tr>
<tr>
<td>Normal</td>
<td>&lt;125</td>
<td>None</td>
</tr>
<tr>
<td>&lt;50</td>
<td>&lt;125</td>
<td>&lt;50</td>
</tr>
<tr>
<td>50–69</td>
<td>125–230</td>
<td>≥50</td>
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<tr>
<td>≥70 but less than</td>
<td>&gt;230</td>
<td>≥50</td>
</tr>
<tr>
<td>near occlusion</td>
<td>High, low, or undetectable</td>
<td>Visible</td>
</tr>
<tr>
<td>Near occlusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total occlusion</td>
<td>Undetectable</td>
<td>Visible, no detectable lumen</td>
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CT Angiography
CTA

- Minimally invasive
- Uses special x-ray equipment to produce multiple images and a computer to join them together in multidimensional views
- Description of procedure
CT Angiography
Benefits

- May eliminate the need for surgery
- Able to detect narrowing in time for corrective surgery to be done
- Gives more precise detail of blood vessels than MRI
- May replace the catheter angiogram and is less invasive
- Cost-effective
- No radiation remains in the body
Risks

- Excessive exposure to radiation causes slight chance of cancer
- Allergy to contrast material, if used
- Skin irritation from leakage of contrast material
- Pregnancy
- Nursing mothers—wait 24 hrs. before breast-feeding
Limitations of CT Angiography

- **Body habitus**—some may not fit into the scanner
- **Should be avoided in diabetes or kidney disease if contrast is used**
- **May be difficult to interpret in severe disease, small tortuous vessels**
MR Angiography (MRA)

- A powerful magnetic field, radio waves and a computer produce the detailed images
- Does not use ionizing radiation (x-rays)
- May be performed with or without contrast
MRA
How does it Work?

- **Does not depend on radiation**
- **While in the magnet, radio waves redirect the axes of spinning protons, which are the nuclei of hydrogen atoms, in a strong magnetic field**
- **The magnetic field is produced by passing an electric current through wire coils in most MRI units**
- **But wait...that’s not all!......**
Other coils, located in the machine and, in some cases, placed around the part of the body being imaged, send and receive radio waves, producing signals that are detected by the coils. A computer then processes the signals and generates a series of images, each of which shows a thin slice of the body.
**Benefits of MRA**

- May eliminate the need for surgery
- Non-invasive, no exposure to radiation
- Shorter recovery time than catheter angiography
- Less costly than catheter angiography
- Contrast material is not iodine-based
Risks

- Almost none
- Excessive sedation if needed
- Medical devices containing metal may malfunction
- Slight risk of allergic reaction to contrast
- Nephrogenic systemic fibrosis with injection of high-dose contrast in persons with poor kidney function
Limitations of MRA

- Unlike CTA, MRA is unable to capture images of calcium deposits
- Clarity of MRA does not yet match that of catheter angiography
- Sometimes difficult to differentiate images of arteries from veins, especially when small
- Inability to lie still or hold breath
- Large build
- Pregnancy—not prohibitive but cautioned
Catheter Angiography
Benefits

- **Detailed, clear and accurate picture of the vessels**
- **Selective study of branch vessels**
- **Possibility if combining diagnosis and treatment in same setting (e.g., angioplasty/atherectomy, stent)**
- **No radiation remains after study**
Risks

- Radiation over-exposure after multiple procedures
- Allergy to contrast materials
- Skin irritation from contrast leak
- Pregnancy/nursing
- Clot formation at tip of catheter
- Artery puncture by catheter
- Renal impairment → injury by contrast
Limitations

- Diabetes, renal disease—not good candidates
- Allergy to dye—use of iodine-free contrast, steroids
- Bleeding tendencies
Underwriting Considerations

- Age
- Symptoms
- Previous manifestations of cerebrovascular disease
- Concurrent risks (diabetes, hypertension, elevated lipids)
- Other vascular disease (PVD, CAD)
Case Presentations

- **J.M.** - 70 yr. old male
- **K.L.** - 42 yr. old female
- **H.B.** - 80 yr. old female
- **C.R.** - 55 yr. old male