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## Vascular – Upper Extremity Duplex Ultrasound

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### Indications:

The indications for peripheral arterial ultrasound examination include, but are not limited to, the following:

1. The detection of stenoses or occlusions in segment(s) of the peripheral arteries in symptomatic patients with suspected arterial occlusive disease. These patients could present with recognized clinical indicators, such as claudication, rest pain, ischemic tissue loss, aneurysm, or arterial embolization.
2. The monitoring of sites of previous surgical interventions, including sites of previous bypass surgery with either synthetic or autologous vein grafts.
3. The monitoring of sites of various percutaneous interventions, including angioplasty, thrombolysis/thrombectomy, atherectomy, or stent placement
4. Follow-up for progression of previously identified disease, such as documented stenosis in an artery that has not undergone intervention, aneurysms, atherosclerosis, or other occlusive diseases
5. The evaluation of suspected vascular and perivascular abnormalities, including such entities as masses, aneurysms, pseudoaneurysms, arterial dissections, vascular injuries, arteriovenous fistulae, thromboses, emboli, or vascular malformations
6. Mapping of arteries prior to surgical interventions
7. Clarifying or confirming the presence of significant arterial abnormalities identified by other imaging modalities
8. Evaluation of arterial integrity in the setting of trauma
9. Evaluation of patients suspected of thoracic outlet syndrome, such as those with positional numbness, pain, tingling, or a cold hand
10. Allen's test to establish patency of palmar arch
11. Temporal artery evaluation to rule out temporal arteritis and/or localize temporal arterial biopsy

### Required Images

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The sonographic examination consists of grayscale/color Doppler imaging and spectral Doppler waveforms in the appropriate arterial segments. Color Doppler should be used to improve detection of arterial lesions by identifying visual narrowing and changes in color and to guide placement of the sample volume for spectral Doppler assessment.

#### A. Appropriate Techniques and Diagnostic Criteria

Specific sonographic techniques must be tailored to the clinical indication, the different arterial segments studied, and the specific pathology being evaluated. Diagnostic criteria for stenosis differ between native and postoperative and postprocedural arteries.

Velocity measurements are obtained from angle-corrected longitudinal spectral Doppler images. Every attempt should be made to acquire images where the angle created by the direction of blood flow and the direction of the ultrasound beam is kept at  $\leq 60$  degrees. Velocity estimates made from images using larger angles are less reliable.

#### B. Arterial Occlusive Disease (Peripheral Arterial Disease)

Physiological tests of the arterial system such as ankle brachial index (ABI), segmental pressure, and waveform analysis are frequently the initial examinations performed to determine the presence of arterial disease and to identify patients appropriate for imaging [22,29,30]. These studies are complementary and not equivalent to the sonographic examination.

The ABI may help evaluate the hemodynamic consequences of lower extremity arterial disease. A contemporaneous ABI, along with imaging, is complementary and supports the imaging findings or, if discrepant, helps avoid pitfalls.

An evaluation of the following arterial segments should generally be performed as indicated below. The accessible portion of the entire vessel or the arterial segment(s) of interest should be evaluated.

1. Lower extremity
  - a. Common femoral artery
  - b. Proximal superficial femoral artery
  - c. Mid superficial femoral artery
  - d. Distal superficial femoral artery/popliteal artery above the knee
  - e. Popliteal artery below the knee

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If clinically appropriate, imaging of the iliac, deep femoral, tibioperoneal trunk, anterior tibial, posterior tibial, peroneal, and dorsalis pedis arteries should be performed.

However, a focused or limited examination may be appropriate in certain clinical situations.

2. Upper extremity
  - a. Subclavian artery
  - b. Axillary artery
  - c. Brachial artery

If clinically appropriate, imaging of the innominate, radial, and ulnar arteries and the palmar arch should be performed.

However, a focused or limited examination may be appropriate in certain clinical situations.

Representative longitudinal color Doppler and/or grayscale images along with angle-corrected spectral Doppler waveforms with velocity measurements should be documented for each normal arterial segment(s).

Suspected abnormalities should be documented with longitudinal grayscale and color Doppler images. Transverse images may be helpful.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images proximal to, at, and distal to sites of suspected stenosis. The sonographer/technologist should evaluate the vessel thoroughly throughout the stenosis to determine the highest peak systolic velocity.

The highest peak systolic velocity in a stenosis should be recorded from an angle-corrected longitudinal spectral Doppler image. A spectral Doppler waveform with velocity measurements should be recorded in the normal arterial segment 1 to 4 cm proximal (upstream) to a suspected stenosis. A waveform distal to a stenosis should be recorded since it is helpful to document a drop in velocity beyond the stenosis and poststenotic disturbed flow/turbulence. Distal abnormalities, as well as a poststenotic tardus parvus waveform, are signs of hemodynamic significance.

The location of any diseased or occluded segment(s) should also be documented. Estimated lengths of diseased or occluded segments may be helpful.

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## C. Evaluation of Surgical and Percutaneous Interventions

### 1. Bypass grafts

An attempt should be made to sample the full length of any arterial bypass graft whenever possible with color Doppler.

Representative longitudinal color Doppler and/or grayscale images should be documented for normal segments.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images.

Angle-corrected spectral Doppler waveforms and peak systolic velocity measurements should be documented in the native artery proximal to the graft anastomosis, at the proximal anastomosis, at representative sites along the graft, at the distal anastomosis, and in the native artery distal to the anastomosis.

Suspected abnormalities should also be imaged with longitudinal grayscale ultrasound. Representative longitudinal color and/or grayscale images of stenoses should be documented. Transverse images may be helpful.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images proximal to, at, and distal to sites of suspected stenosis. The sonographer/technologist should evaluate the vessel thoroughly throughout the stenosis to determine the highest peak systolic velocity.

The highest peak systolic velocity in a stenosis should be recorded from an angle-corrected longitudinal spectral Doppler image. A spectral Doppler waveform with velocity measurements should be recorded in the normal arterial segment 1 to 4 cm proximal (upstream) to a suspected stenosis. A waveform distal to a stenosis should be recorded since it is helpful to document a drop in velocity beyond the stenosis and poststenotic disturbed flow/turbulence and/or tardus parvus waveform.

### 2. Endovascular interventions

An attempt should be made to sample the site of arterial interventions as well as the segment immediately proximal (upstream) and distal (downstream) to the site of intervention. Stents should generally be scanned along their entire length, and representative images within the stent should be

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obtained.

Representative longitudinal color Doppler and/or grayscale images should be documented.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images.

Angle corrected spectral Doppler waveforms and peak systolic velocity measurements should be documented in the native artery proximal to the intervention, at the interventional site, and in the native artery distal to the intervention.

Suspected abnormalities should also be imaged with longitudinal grayscale ultrasound. Representative longitudinal color and/or grayscale images of stenoses should be documented. Transverse images may be helpful.

Angle-corrected spectral Doppler waveforms should be obtained from longitudinal images proximal to, at, and distal to sites of suspected stenosis. The sonographer/technologist should evaluate the vessel thoroughly throughout the stenosis to determine the highest peak systolic velocity.

The highest peak systolic velocity in a stenosis should be recorded from an angle-corrected longitudinal spectral Doppler image. A spectral Doppler waveform with peak systolic velocity measurements should be recorded in the normal arterial segment 1 to 4 cm proximal (upstream) to a suspected stenosis. A waveform distal to a stenosis should be recorded since it is helpful to document a drop in velocity beyond the stenosis and poststenotic disturbed flow/turbulence and/or tardus parvus waveform.

#### D. Other

##### 1. Suspected soft-tissue abnormalities in proximity to arteries

The entire area of a suspected soft-tissue abnormality should be imaged. If appropriate, spectral and color Doppler may be performed to determine the presence and nature of blood flow in the region of the suspected abnormality.

##### 2. Pseudoaneurysms

In evaluating patients with suspected pseudoaneurysms, the sonographer/technologist should generally scan at and on either side of the site of trauma/puncture since the vessel may have been punctured at or several centimeters from the skin wound.

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Hematomas should be differentiated from pseudoaneurysms with appropriate technique to detect flow, thereby avoiding false-positive results. Hematomas, if present, should be documented. When a pseudoaneurysm is identified, the size of the pseudoaneurysm, the size of the residual lumen, and the length and width of the communicating channel should be documented with appropriate grayscale and color Doppler techniques. Spectral Doppler waveforms should be obtained in the communicating channel to demonstrate “to-and-fro” flow.

In case of therapeutic intervention, color and/or spectral Doppler may be used as a guide to therapy and as a means of documenting therapeutic success.

### 3. Abnormal communication between artery and vein

Color and spectral color Doppler may be used to document the location of abnormal vascular communications. Spectral Doppler waveforms should be documented from the artery proximal to, in the area of, and distal to abnormal communications. Flow within the fistula should be recorded, if found. A spectral Doppler waveform from the draining vein should be documented.

Color Doppler is particularly useful for identifying the level of such communications because the flow disturbances in a fistula often create color in the adjacent soft tissue from transmitted vibrations and pressure changes (color bruit).

### 4. Peripheral aneurysms

The location of aneurysms should be documented. The widest diameter of the artery or aneurysm should be measured (outer wall to outer wall) on grayscale images in a plane perpendicular to the long axis of the lumen. If present, patency and the presence of intraluminal thrombus should be documented with color Doppler.