CAROTID VASCULAR ULTRASOUND

Mohammad Syahrir Azizi
Division Cardiovascular, Dept of Internal Medicine
Faculty of Medicine Universitas Indonesia/ Ciptomangunkusumo Hospital
Carotid Doppler (CD) → Carotid Artery Ultrasound

Indication
1. Transient ischemic attack
2. Reversible ischaemic neurological deficit
3. Mild resolving strokes in younger patients
4. Atypical, non focal symptoms which may have a vascular aetiology
5. Arteriopathies / high risk patients prior to surgery
6. Post endarterectomy
7. Pulsatile neck masses
8. Trauma / dissection
9. Disease screening
Ultrasound Physics

- Sound waves are longitudinal
- Mechanical radiant energy, converted to heat in tissue
Probe transducer

Compromise between resolution and penetration

\[ v = \lambda f \]

High frequency → less penetration
Probe Orientation

Transverse View
Marker points to patient right side

Longitudinal View
Marker points to patient head
Posture and probe orientation

- **Posterolateral**
- **Anterolateral**
Method of imaging

<p>| | |</p>
<table>
<thead>
<tr>
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<tbody>
<tr>
<td>1.</td>
<td>B mode</td>
</tr>
<tr>
<td>2.</td>
<td>Color doppler</td>
</tr>
<tr>
<td>3.</td>
<td>Pulse wave doppler</td>
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<tr>
<td>4.</td>
<td>Other : M mode, Power doppler, 3D</td>
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</tbody>
</table>
B Mode B mode (Brightness mode, grayscale, 2D)

- Anatomical assessment
  - IMT thickness, plaque, thrombus, stenosis, tortuous
  - Other structure (IJV, mass, thyroid)
Arterial diameter

Measure in contraction phase (late diastolic)
Intima Media Thickness

- IMT is defined as a double-line pattern visualised by echo 2D on both walls of the common carotid artery (CCA) in a longitudinal view.
- Two parallel lines (leading edges of two anatomical boundaries) form it: lumen-intima and media-adventitia interfaces.
- Damage is defined as the presence of IMT >0.9 mm or plaque (ESC).
Computerized IMT

Equipment settings
• Focus depth (30-40 mm), frame rate (>15-25 Hz)
• Gain settings adjusted optimally to facilitate edge detection;
• Clear 3-lead electrocardiographic signal;
• Use of a zoom function is discouraged (most of the studies have not used zoomed images);
IMT measurement

- At least 5 mm below the distal end of CCA, could also be measured at
  - the carotid bifurcation and internal carotid artery bulb, but the values should be given separately
- free of atherosclerotic plaque with clearly defined lumen-intima and media-adventitia interfaces
- 10-mm-in-length straight arterial segment is required;
- The far wall of the common carotid artery is preferred
- IMT measured at end-diastole (R wave);
- Automatic or semi-automatic IMT measurement, online or offline
  - Point-to-point measurement of IMT is not recommended;
- IMT values averaged (higher values at left side)
Plaque and stenosis
Classification of plaque

Echogenicity

- Hyperechoic
- Isoechoic
- Hypoechoic
- Anechoic

Table 1. Classification of Plaque

<table>
<thead>
<tr>
<th>Hemodynamic (% Stenosis Diameter)</th>
<th>Morphologic</th>
<th>By Surface</th>
</tr>
</thead>
<tbody>
<tr>
<td>H1, mild (&lt;50%)</td>
<td>P1, homogeneous</td>
<td>S1, smooth</td>
</tr>
<tr>
<td>H2, moderate (50%-69%)</td>
<td>P2, heterogeneous</td>
<td>S2, irregular (defect &lt;2 mm)</td>
</tr>
<tr>
<td>H3, severe (70%-95%)</td>
<td></td>
<td>S3, ulcerated (defect &gt;2 mm)</td>
</tr>
<tr>
<td>H4, critical (95%-99%)</td>
<td></td>
<td></td>
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<tr>
<td>H5, occluding (100%)</td>
<td></td>
<td></td>
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</tbody>
</table>

From Thiele et al.19
Appearance of atheromatous plaques

Homogeneous echolucent

Heterogeneous plaque

Homogeneous echogenic

Cauliflower’ calcification

Ulcerated Plaque

Sources of error in ulcer diagnosis

- Image plan does not include the ulcer
- Adjacent plaque simulate ulceration
- Plaque surface irregular but not ulcerated

Zwiebel WL. Introduction to vascular ultrasonography.
Plaque and stenosis degree

1. ECST method
   - Margin of bulb estimated from arteriogram for $D$
   - $D - d \over D = \%$ diameter stenosis
   - Example: $10 - 2 \over 10 = 80\%$ diameter stenosis

2. NASCET method
   - Diameter of ICA taken for $D$
   - $D - d \over D = \%$ diameter stenosis
   - Example: $4 - 2 \over 4 = 50\%$ diameter stenosis

3. Common carotid diameter method
   - Diameter of upper CCA is taken for $D$
   - $D - d \over D = \%$ diameter stenosis
   - Example: $8 - 2 \over 8 = 75\%$ diameter stenosis
Pulse Wave Doppler
A Spectrum Doppler Waveform

- Spectrum waveform are used primarily to quantify velocity and stenosis.

- Color box
- Sample volume
- Spectral doppler
- PSV
- EDV
- MDV
- RI
- PI
- TAPV
Carotid Spectral Waveform
ICA vs ECA

<table>
<thead>
<tr>
<th>Features</th>
<th>ICA</th>
<th>ECA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>Usually larger</td>
<td>Usually smaller</td>
</tr>
<tr>
<td>Branches</td>
<td>Rarely</td>
<td>Yes</td>
</tr>
<tr>
<td>Orientation</td>
<td>Posterior</td>
<td>Anterior</td>
</tr>
<tr>
<td>Pulsed Doppler</td>
<td>Low resistance</td>
<td>High resistance</td>
</tr>
<tr>
<td>Temporal tap</td>
<td>Usually negative</td>
<td>Usually positive</td>
</tr>
</tbody>
</table>
Vertebral Artery Waveform
Vertebral artery abnormality

Route of flow in left vertebral steal

Vertebral-to-subclavian steal

Compared to bunny in profile

Incomplete steal

Complete steal


How to report?

1. Data pasien
2. Patensi CCA, ICA, ECA
3. Variasi anatomi
4. Rasio peak systoli IC / CC (kanan – kiri)
5. Derajat stenosis, tipe plak, permukaan plak
6. Panjang stenosis
7. Diameter ICA diatas stenosis
8. Arteri vertebralis (terlihat? Arah aliran? Abnormalitas?)
Syukron