EXTRACRANIAL INSONATION: TRICKS AND PITFALLS

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“Il fondamento dell’arte medica resta, secondo la mia opinione, l’essere padrone del metodo di indagine..”

Ippocrate
Carotid Artery Duplex Ultrasound
PWD

60° 1.5 mm wide
Internal / Common Carotid
Internal / Common Carotid
Peak Systolic Velocity vs. Stenosis

\[ \text{Velocity (cm/sec)} \]

\[ \text{Angiography - Diameter Stenosis (\%)} \]
• CONTRALATERAL OCCLUSION
• LOW OR HIGH CARDIAC OUTPUT STATES
• ARRHYTMIAS
• ANEMIA/HEMODILUTION
• TIGHT STENOSIS AT THE CAROTID SIPHON SITE
• AORTIC VALVE STENOSIS OR INSUFFICIENCY

$$\text{PSV}_{\text{ICA}} / \text{PSV}_{\text{CCA}}$$ is convenient
PSV_{ICA}/PSV_{CCA} vs. Stenosis
<table>
<thead>
<tr>
<th>Percentage</th>
<th>PSV&lt;sub&gt;ICA&lt;/sub&gt; (cm/s)</th>
<th>EDV&lt;sub&gt;ICA&lt;/sub&gt; (cm/s)</th>
<th>PSV&lt;sub&gt;ICA&lt;/sub&gt;/PSV&lt;sub&gt;CCA&lt;/sub&gt; (cm/s)</th>
<th>SENS %</th>
<th>SPEC %</th>
<th>ACC %</th>
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<tbody>
<tr>
<td>50%</td>
<td>125</td>
<td></td>
<td></td>
<td>83</td>
<td>93</td>
<td>92</td>
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<tr>
<td>60%</td>
<td>260</td>
<td>70</td>
<td>3.2</td>
<td>84</td>
<td>94</td>
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<tr>
<td>70%</td>
<td>270</td>
<td>110</td>
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<td>96</td>
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<tr>
<td>80%</td>
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<td>140</td>
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<td>84</td>
<td>87</td>
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<td>NEAR OCCL.</td>
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<tr>
<td>OCCLUDUS</td>
<td>&lt;50</td>
<td>NO</td>
<td>SIGNAL</td>
<td></td>
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</tbody>
</table>
Internal Carotid Stenosis

\[ \text{PSV}_{ICA}/\text{PSV}_{CCA} = 3.5 \]

>60%
ANGLE CORRECTION is

- VERY UNCERTAIN

- The measurement of blood velocity is very inaccurate, and stenosis can only be estimated through wide steps of severity
Internal / Common Carotid

Col 68% Map 5
WF Low
PRF 3000 Hz
Flow Opt: Med V

SV Angle –60°
Dep 2.5 cm
Size 1.5 mm
Freq 6.0 MHz
WF Low
Dop 58% C 4
PRF 8333 Hz
FLOW PROFILE is

- HELICAL IN STRAIGHT VESSELS
- SQUEWED IN CURVED VESSELS
- CONVERGENT INTO STENOSIS
- TURBULENT IN MANY PHYSIOLOGIC CONDITIONS
LIMITATIONS OF ANGIOGRAPHY AS “GOLD STANDARD”

- INTER-OBSERVER AND INTRAOBSERVER VARIABILITY
  (agreement 78% and 83%, for a 70% stenosis)
- USED ONLY IN SELECTED PATIENTS
- IT SHOWS DIAMETER REDUCTION
NASCET

North American Symptomatic Carotid Endarterectomy Trial
NASCET Measurement Method = (1 - A/B) * 100
\[ Q = V \times A \]

\[ V_1 \times A_1 = V_2 \times A_2 \]

\[ \frac{V_2}{V_1} = \frac{A_1}{A_2} \]
Most symptomatic patients have stenosis smaller than 50%.

The majority of patients with higher stenotic plaques remain symptom-free.
US CHARACTERIZATION OF CAROTID PLAQUES

• ECHOGENECITY
  - anechoic, isoechoic, hyperechoic

• TEXTURE
  - homogeneous, heterogeneous

• SURFACE CONTOUR
  - smooth, mildly irregular, ulcerated (>2 mm in depth and width)
US CHARACTERIZATION OF CAROTID PLAQUES

- **TYPE 1**: low echogenicity
- **TYPE 2**: intermediate low echog.
- **TYPE 3**: intermediate high echog.
- **TYPE 4**: high echogenicity
- **TYPE 5**: unclassified due to calcium
US CHARACTERIZATION OF CAROTID PLAQUES

PITFALLS

same plaque

• 7.5 MHz = hypo-echogenic (echo-lucent)
• 20 MHz = hyper-echogenic (echo-rich)
US CHARACTERIZATION OF CAROTID PLAQUES

PITFALLS

• SUBJECTIVE
  (GSM concept)

• DIFFICULT TO REPRODUCE
  (lack of pointing facilities)

• CALCIUM
  (21-48% of plaques)
B-mode

CFM

↑↓
DUPLEX SCANNING is

- OPERATOR DEPENDENT
- MACHINE DEPENDENT
- LABORATORY-SPECIFIC CRITERIA (even for multicenter trials)
- CONTINUING QUALITY CONTROL PROCESS