ECHOCOLOR DOPPLER LESSONS

MEASURING THE DEGREE OF ICA STENOSIS: HOW TO DO IT?

CONSENSUS AND CASE REPORTS

FRANCO ACCORSI
MEASURING THE DEGREE OF ICA STENOSIS: HOW TO DO IT?
CONSENSUS AND CASE REPORTS

INTRODUCTION

The main parameter that should be used in diagnosing and grading the internal carotid artery (ICA) hemodynamic stenosis is the peak systolic velocity (PSV), but grading based only on the PSV is not sufficient to differentiate a moderate from a severe (70% NASCET) stenosis with sufficient clinical reliability. In these cases the PSV criterion taken alone is of limited value. Grading based on a set of main and additional criteria can overcome diagnostic errors: in particular it is recommended the study of the post stenotic flow velocity distal to flow disturbances and the study of the collateral flows through the anterior/posterior communicating artery.

In this lesson are reported: A) the recommendations proposed by two Consensus Panels (1. Society of Radiologists in Ultrasound Consensus Conference. Radiology 2003; and 2. Neurosonology Research Group of the World Federation of Neurology. Stroke 2012) in order to provide reliable information regarding the diagnosis of the degree of ICA stenosis; B) some explicative case reports.
CAROTID ARTERY STENOSIS: US DIAGNOSIS

DEGREE OF ICA STENOSIS: HOW TO DO IT?
DEGREE OF ICA STENOSIS: 
Considerations and doubts

1. the problem is not yet completely solved:
   - there is no uniformity in the interpretation between the different centers or between the professionals of the same center

2. confusion in the interpretation of data:
   - the different “primary” or “secondary” parameters associated with
   - the different ECST/NASCET angiographic-like measurement have produced some confusion in the interpretation of data with the risk of over/underestimating the degree of ICA stenosis
DEGREE OF ICA STENOSIS: HOW TO DO IT?

1. CONSENSUS 2003

- A multidisciplinary group of experts proposed, in 2003, recommendations in order to provide reproducible and reliable information regarding the diagnosis and the degree of ICA stenosis.

*Carotid Artery Stenosis: Gray-Scale and Doppler US Diagnosis—Society of Radiologists in Ultrasound Consensus Conference. Radiology 2003*
### CONSENSUS CONFERENCE 2003

The degree of stenosis determined at gray-scale and Doppler US should be stratified into six categories: 1) normal (no stenosis); 2) < 50% stenosis; 3) 50%–69% stenosis; 4) ≥ 70% stenosis to near occlusion; 5) near occlusion; 6) total occlusion.

1. **primary US parameters**
   a) ICA PSV
   b) presence of plaque on gray-scale and/or color Doppler US images

2. **additional US parameters**
   a) ICA/CCA PSV ratio
   b) ICA EDV
CAROTID ARTERY STENOSIS: US DIAGNOSIS

CONSENSUS CONFERENCE 2003
SOCIETY OF RADIOLOGISTS IN ULTRASOUND

1. ICA should be diagnosed as normal when ICA PSV is < 125 cm/sec and no plaque or intimal thickening is visible
   a) color: no plaque is visible
   b) ICA PSV = 69 cm/sec (< 125 cm/sec)

CONCLUSION: ICA NORMAL
### CAROTID ARTERY STENOSIS: US DIAGNOSIS

<table>
<thead>
<tr>
<th>Degree of Stenosis (%)</th>
<th>Primary Parameters</th>
<th>Additional Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>ICA PSV (cm/sec)</td>
<td>ICA/CCA PSV Ratio</td>
</tr>
<tr>
<td>0-50</td>
<td>&lt;125</td>
<td>&lt;2.0</td>
</tr>
<tr>
<td>50-69</td>
<td>125-230</td>
<td>2.0-4.0</td>
</tr>
<tr>
<td>≥70 but less than</td>
<td>&gt;230</td>
<td>&gt;4.0</td>
</tr>
<tr>
<td>near occlusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Near occlusion</td>
<td>High, low, or</td>
<td>Variable</td>
</tr>
<tr>
<td>Total occlusion</td>
<td>Plaque Estimate (%)</td>
<td>Visible</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>Not applicable</td>
</tr>
<tr>
<td></td>
<td>&lt; 50</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

**CONSENSUS CONFERENCE 2003**

**SOCIETY OF RADIOLOGISTS IN ULTRASOUND**

2. ICA should be diagnosed as <50% stenosis when ICA PSV is < 125 cm/sec and plaque or intimal thickening is visible

a) power: plaque is visible (diameter reduction < 50%)
b) ICA PSV = 50 cm./sec. (< 125 cm/sec)

**CONCLUSION: DEGREE OF STENOSIS < 50%**
CAROTID ARTERY STENOSIS: US DIAGNOSIS

**CONSENSUS CONFERENCE 2003**
SOCIETY OF RADIOLOGISTS IN ULTRASOUND

3. ICA should be diagnosed as 50%–69% stenosis when ICA PSV is 125–230 cm/sec and plaque is visible

a) color: plaque is visible (diameter reduction ≥ 50%)

b) ICA PSV = 219 cm/sec

**CONCLUSION: DEGREE OF STENOSIS 50-69%**
CAROTID ARTERY STENOSIS: US DIAGNOSIS

<table>
<thead>
<tr>
<th>Degree of Stenosis (%)</th>
<th>ICA PSV (cm/sec)</th>
<th>Plaque Estimate (%)*</th>
<th>ICA/CCA PSV Ratio</th>
<th>ICA (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;125</td>
<td>None</td>
<td>&lt;2.0</td>
<td>&lt;40</td>
</tr>
<tr>
<td>&lt;50</td>
<td>&lt;125</td>
<td>&lt;50</td>
<td>&lt;2.0</td>
<td>&lt;40</td>
</tr>
<tr>
<td>50–69</td>
<td>125–230</td>
<td>≥50</td>
<td>2.0–4.0</td>
<td>40–100</td>
</tr>
<tr>
<td>≥70 but less than near occlusion</td>
<td>&gt;230</td>
<td>≥50</td>
<td>&gt;4.0</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Near occlusion</td>
<td>High, low, or undetectable</td>
<td>Visible</td>
<td>Variable</td>
<td>Variable</td>
</tr>
<tr>
<td>Total occlusion</td>
<td>Undetectable</td>
<td>Visible, no detectable lumen</td>
<td>Not applicable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

CONSENSUS CONFERENCE 2003
SOCIETY OF RADIOLOGISTS IN ULTRASOUND

4. ICA should be diagnosed as ≥70% stenosis to near occlusion when PSV is > 230 cm/sec and visible plaque and lumen narrowing are seen

a) color: visible plaque and lumen narrowing are seen (diam. reduction ≥ 50%)
b) ICA PSV = 273 cm/sec (> 230 cm/sec)

CONCLUSION: STENOSIS ≥70% BUT NOT NEAR OCCLUSION
CAROTID ARTERY STENOSIS: US DIAGNOSIS

<table>
<thead>
<tr>
<th>Degree of Stenosis (%)</th>
<th>ICA PSV (cm/sec)</th>
<th>Plaque Estimate (%)</th>
<th>Additional Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>&lt;125</td>
<td>None</td>
<td>ICA/CCA PSV Ratio</td>
</tr>
<tr>
<td>&lt;50</td>
<td>&lt;125</td>
<td>&lt;50</td>
<td>&lt;2.0</td>
</tr>
<tr>
<td>50–69</td>
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<td>&lt;4.0</td>
</tr>
<tr>
<td>≥70 but less than</td>
<td>&gt;230</td>
<td>≥50</td>
<td>2.0–4.0</td>
</tr>
<tr>
<td>near occlusion</td>
<td></td>
<td></td>
<td>40–100</td>
</tr>
<tr>
<td>Total occlusion</td>
<td>Undetectable</td>
<td>Visible</td>
<td>Variable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No detectable</td>
<td>Not applicable</td>
</tr>
</tbody>
</table>

CONSENSUS CONFERENCE 2003
SOCIETY OF RADIOLOGISTS IN ULTRASOUND

5. ICA should be diagnosed as near occlusion when there is a markedly narrowed lumen at color US. ICA PSV may be high, low or undetectable

a) B-mode: markedly narrowed lumen
b) ICA PSV high and low (in this case)

CONCLUSION: NEAR OCCLUSION
6. ICA should be diagnosed as total occlusion when there is no detectable patent lumen at B-mode and no flow at spectral, power, color Doppler US

a) B-mode/color US: no detectable patent lumen (longitudinal and transverse scan)
b) CCA spectral analysis: high resistance flow for the ICA occlusion

CONCLUSION: OCCLUSION
CAROTID ARTERY STENOSIS: US DIAGNOSIS

<table>
<thead>
<tr>
<th>Degree of Stenosis (%)</th>
<th>Primary Parameters</th>
<th>Additional Parameters</th>
</tr>
</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>140 to 230 cm/s</td>
<td>≥50</td>
</tr>
<tr>
<td>≥70 but less than near occlusion</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>Total occlusion</td>
<td>Undetectable</td>
<td>Visible, no detectable lumen</td>
</tr>
</tbody>
</table>


- the CDUS and angiography results of 376 carotid arteries were analyzed
- the consensus criteria for diagnosing **50% to 69%** stenosis can be significantly improved by using an **ICA PSV of 140 to 230 cm/s**, with a sensitivity of 94%, specificity of 92%, and overall accuracy of 92%

DEGREE OF ICA STENOSIS: HOW TO DO IT?

2. CONSENSUS 2012

- a group of experts, with the aim to summarize the internationally available experience with US grading of carotid stenosis, including a consensus approved (in 2010) by all German medical societies active in the field of carotid ultrasound, proposed some recommendations, in 2012

CONSENSUS 2012

Consideration 1:

There are many reasons why the PSV criterion is frequently in disagreement with the angiographic result and is of limited value taken alone:

1. There is the morphology of the stenosis (area versus diameter, irregularities ill-represented by all imaging modalities)
2. The possibility of the same velocity in a moderate stenosis and a nearly occluded artery
3. The angle can be estimated fairly well in laminar flow conditions but it is difficult with disturbed flow, where streamlines differ from the vessel course
4. The influence of collateral flow. Velocities in a stenosis depend on collateral flow toward the territory supplied by the stenosed artery.
5. The Doppler spectrum generated by a short stenosis is typically composed by high-frequency (velocity) components representing the jet, and low-frequency ones attributable to vortices and flow separation. This can lead to underestimation of the PSV

Taking into consideration all these factors, it seems evident that PSV as a single simplified diagnostic parameter is insufficient.

Grading carotid stenosis using ultrasonic methods. Stroke 2012
CONSENSUS 2012
Consideration 2:
the sole criterion of the PSV has limitations

- any decision based only on a carotid scan at the neck level and a single velocity (PSV) value has serious limitations
- diagnostic ultrasound has the potential to classify and grade carotid disease with high reliability, taking into account morphological and complex hemodynamic parameters
- these parameters represent physiological variables correlating with prognosis

*Grading carotid stenosis using ultrasonic methods. Stroke 2012*
GRADING CAROTID STENOSIS USING ULTRASONIC METHODS

- The controversy as to whether Doppler ultrasonic methods should play a role in clinical decision-making in the prevention of stroke is attributable to reported disagreement between angiographic and ultrasonic results and the lack of internationally accepted ultrasound criteria for describing the degree of stenosis.

- Foremost among the explanations for both is the broad scatter of peak systolic velocities in the stenosis, the criterion that has so far received most attention.

Grading based on a set of main and additional criteria can overcome diagnostic errors.

*Grading Carotid Stenosis Using Ultrasonic Methods. Stroke 2012*
ADVANTAGES OF A MULTIPARAMETRIC APPROACH

Diagnostic ultrasound offers the possibility of using both morphological and hemodynamic criteria. In the following, the main steps of grading are described.

1. Low-Degree Stenosis 0% to 40% (NASCET)

This is the domain of B-mode imaging in the longitudinal and cross-sectional planes. Velocity measurement rules out a more severe stenosis sometimes suggested by an inappropriate sectional plane. It is recommended to measure, in addition to the reduction of diameter in percent, the thickness and length of the plaque as well as the residual lumen.

2. Moderate Stenosis 50% to 60% (NASCET)

This is a class of stenosis in which local increase of velocity, color flow, and B-mode imaging can be combined for grading. PSV is, in general, 230 cm/s. Collateral flow is not present.

ADVANTAGES OF A MULTIPARAMETRIC APPROACH

Diagnostic ultrasound offers the possibility of using both morphological and hemodynamic criteria. In the following, the main steps of grading are described

3. Hemodynamically Relevant Stenosis >70% (NASCET)

This is the domain of combined hemodynamic criteria, such as increased PSV or end-diastolic velocity or the “carotid ratio” (ratio of internal to common carotid PSV), but there is a considerable overlap with moderate stenoses.

Collateral flow is demonstrated by examining the ophthalmic artery branches (Doppler ophthalmic test), the anterior cerebral artery, proving cross-flow or the P1 segment of the posterior cerebral artery, indicating collateral flow through the posterior communicating artery.

In case of established collateral flow, hemodynamic relevance of the stenosis is proven and it can be classified as high-degree (70% NASCET irrespective of the intrastenotic PSV).

Poststenotic flow velocity in the segment distal to the disturbed flow field is another criterion.

*Grading Carotid Stenosis Using Ultrasonic Methods. Stroke 2012*
## Carotid Artery Stenosis: US Diagnosis

### Main and Additional Criteria Combined Criteria for Grading Internal Carotid Stenosis.

*Grading Carotid Stenosis Using Ultrasonic Methods. Stroke 2012*

<table>
<thead>
<tr>
<th>Degree of Stenosis as Defined by NASCET (%)</th>
<th>10–40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>Occlusion</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Main criteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. B-mode image, diameter</td>
<td>Applicable</td>
<td>Possibly applicable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Imaging of occluded artery</td>
</tr>
<tr>
<td>3. PSV threshold (cm/s)</td>
<td>≤160</td>
<td>125</td>
<td>230</td>
<td>NA</td>
<td>NA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4a. PSV average (cm/s)</td>
<td></td>
<td>210</td>
<td>240</td>
<td>330</td>
<td>370</td>
<td>Variable</td>
<td>NA</td>
</tr>
<tr>
<td>4b. PSV poststenotic (cm/s)</td>
<td></td>
<td>≥50</td>
<td>&lt;50</td>
<td>&lt;30</td>
<td></td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>5. Collateral flow (periorbital arteries or circle of Willis)</td>
<td></td>
<td>Possible</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td>Present</td>
<td></td>
</tr>
<tr>
<td><strong>Additional criteria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Prestenotic flow (diastole) (CCA)</td>
<td></td>
<td>Possibly reduced</td>
<td>Reduced</td>
<td>Reduced</td>
<td>Reduced</td>
<td>Reduced</td>
<td></td>
</tr>
<tr>
<td>7. Poststenotic flow disturbances (severity and length)</td>
<td>Moderate</td>
<td>Pronounced</td>
<td>Pronounced</td>
<td>Pronounced</td>
<td>Variable</td>
<td>NA</td>
<td></td>
</tr>
<tr>
<td>8. End-diastolic flow velocity in the stenosis (cm/s)</td>
<td>&lt;100</td>
<td>&gt;100</td>
<td>Variable</td>
<td>NA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Carotid ratio ICA/CCA</td>
<td>&lt;2</td>
<td>≥2</td>
<td>≥2</td>
<td>&gt;4</td>
<td>&gt;4</td>
<td>Variable</td>
<td>NA</td>
</tr>
</tbody>
</table>

These criteria do not apply for external carotid stenosis. Note the hierarchical order of main and additional criteria and the change of reliability of each criterion for different degrees of stenosis. Examples how to use this Table are given in the text under "Main and Additional Criteria" and "Advantages of a Multiparametric Approach." For definition of classes of stenosis, see Figure legend.

Criterion 1: Visualization of the ICA by B-mode imaging is needed to prove no flow.
Criterion 4a: Values taken from Figure.
Criterion 4b: Poststenotic indicates measured distal to turbulences. In case of a short neck or a bifurcation in high position, respectively, these criteria are difficult to assess with a conventional duplex technique. Then, a lateral scan head position behind the jaw angle or a scan head with a lower frequency, as for abdominal examinations, may give access to the more distal lying segments of the ICA. Another possibility is the examination of the distal ICA with 2-MHz pulsed Doppler sonography.
Criterion 6: “Reduced” means side-to-side difference, mainly in diastolic velocity.
Modified from reference 11.

CCA indicates common carotid artery; ICA, internal carotid artery; NA, not applicable; PSV, peak systolic velocity.
RECOMMENDATIONS 1

- the NASCET method of measuring a stenosis should be the standard; the local narrowing (ECST) can be measured in addition, but it must be declared as such.

**Grading Carotid Stenosis Using Ultrasonic Methods. Stroke 2012**
RECOMMENDATIONS 1

- the NASCET method of measuring a stenosis should be the standard; the local narrowing (ECST) can be measured in addition, but it must be declared as such


DEGREE OF ANGIOGRAPHIC ICA STENOSIS

1. NASCET method: B - A/B x 100

B is the ICA diameter in the disease-free distal to the stenosis, while A is the residual lumen at the point of maximum stenosis

2. ECST method: C - A/C x 100

C is the original normal arterial diameter would have been at the point of maximum stenosis as angiography only shows the residual lumen
RECOMMENDATIONS 1:
The NASCET method of measuring a stenosis should be the standard.
1. plaque studied with color/power Doppler and spectral analysis
2. the flow velocity is fundamental to assess the severity of the ICA stenosis
   in this case PSV = 261 cm./sec. corresponding to NASCET stenosis > 80% and ECST stenosis > 90%
RECOMMENDATIONS 2

in low to moderate degrees of stenosis:

- grading of carotid stenosis by diagnostic US should be primarily based on morphological information (B-mode, color flow)
- in addition to degree of narrowing, plaque thickness, plaque length, and residual lumen should be reported

RECOMMENDATIONS 2

In low to moderate degrees of stenosis:
1. B-mode/color-Doppler allows a good evaluation of the plaque morphology
2. spectral analysis (PSV = 76.61 cm./sec., allows to exclude the presence of a hemodynamic plaque

in this case the degree of stenosis cannot be assessed with spectral analysis (but only with longitudinal and cross-scan)
RECOMMENDATIONS 3

**moderate from a severe (70% NASCET) stenosis**

- velocity measurements in a stenosis (PSV and carotid ratio) alone are not sufficient to differentiate a moderate from a severe (70% NASCET) stenosis with sufficient clinical reliability
- it is recommended a search for collateral flow: ophthalmic artery branches (CW Doppler) or the anterior cerebral artery (TCCD)
- it is recommended that the poststenotic flow velocity distal to flow disturbances is examined, in which a reduction of velocities (comparison with the unaffected contralateral side or absolute reduction) allows additional grading within the category of severe stenosis
- hemodynamic criteria are appropriate for grading moderate to severe stenoses. Criteria should be considered in a hierarchical order. Established collateral flow is the most powerful criterion, excluding a less than severe stenosis irrespective of PSV

*Grading Carotid Stenosis Using Ultrasonic Methods. Stroke 2012*
CAROTID ARTERY STENOSIS: US DIAGNOSIS

1. ICA stenosis. PSV = 233 cm/s. Moderate/severe (70% NASCET) stenosis

2. Poststenotic flow velocity distal to ICA stenosis

3. PSV distal to flow disturbances (43 cm/s)

RECOMMENDATIONS 3
In moderate from a severe (70% NASCET) stenosis:

- PSV and carotid ratio alone are not sufficient to differentiate a moderate from a severe (70% NASCET) stenosis with sufficient clinical reliability
- It is recommended that the poststenotic flow velocity distal to flow disturbances is examined, in which a reduction of velocities (comparison with the unaffected contralateral side or absolute reduction) allows additional grading within the category of severe stenosis

RECOMMENDATIONS 3

- special care is recommended for converting Doppler frequencies into velocity by measuring the angle of incidence (Doppler angle)
- measurements should be taken using the lowest possible angle of insonation (made in relation to the direction of the jet visualized by color velocity flow and not the vessel course)
- with an irregular stenosis, overestimation of velocities attributable to disturbed or helical flow has to be taken into consideration

*Grading Carotid Stenosis Using Ultrasonic Methods. Stroke 2012*
CASE REPORTS:
is the ICA PSV sufficient
in the evaluation of the degree of stenosis?
CASE REPORT 1

a. ICA PSV = 176 cm/s.
b. EDV = 58 cm/sec.

ICA stenosis?
CASE REPORT 1
ICA PSV = 176 cm./sec.; EDV = 58 cm./sec → NASCET stenosis 50-60% (ECST stenosis 75-85%)
CASE REPORT 1

In NASCET stenosis 50%-60%, the poststenotic and siphon flow velocities?
CASE REPORT 1

PSV = 176 cm/s: ICA moderate stenosis (50% to 60%, NASCET). The post stenotic and siphon flow velocities are normal.

- This is a class of stenosis in which local increase of velocity, color flow, and B-mode imaging can be combined for grading. PSV is, in general, 230 cm/s. Collateral flow is not present.

*Grading Carotid Stenosis Using Ultrasonic Methods. Stroke 2012*
CAROTID ARTERY STENOSIS: US DIAGNOSIS

CASE REPORT 2

a. ICA PSV = 337 cm/s;
b. EDV = 103 cm/sec.
ICA stenosis?
ICA PSV = 337 cm./sec.; EDV = 103 cm./sec \rightarrow \text{NASCET stenosis } > 80\% \text{ (ECST stenosis } > 90\%)
CASE REPORT 2

In NASCET stenosis >80%, the poststenotic and siphon flow velocities?
CAROTID ARTERY STENOSIS: US DIAGNOSIS

1. ICA severe stenosis. PSV = 337 cm/s.

2. poststenotic flow velocity distal to ICA stenosis

3. anterior and posterior communicating artery activated

CASE REPORT 2

PSV = 337 cm/s: Hemodynamically Relevant Stenosis >70% (NASCET)

This is the domain of combined hemodynamic criteria, such as increased PSV or EDV or the "carotid ratio" (ratio of internal to common carotid PSV), but there is a considerable overlap with moderate stenoses.

Collateral flow is demonstrated by examining the ophthalmic artery branches, the ACA, proving cross-flow or the P1 segment of the PCA, indicating collateral flow through the post. communicating artery.

In case of established collateral flow, hemodynamic relevance of the stenosis is proven and it can be classified as high-degree (70% NASCET irrespective of the intrastenotic PSV). Poststenotic flow velocity in the segment distal to the disturbed flow field is another criterion. Grading Carotid Stenosis Using Ultrasonic Methods. Stroke 2012
CAROTID ARTERY STENOSIS: US DIAGNOSIS

CASE REPORT 3: BILATERAL ICA SEVERE STENOSIS

- PSV ICA rt. = 2.59 m/s;
- PSV ICA lt. = 2.36 m/s;
CAROTID ARTERY STENOSIS: US DIAGNOSIS

CASE REPORT 3

- the same velocities (PSV ICA rt. = 2.59 m/s.; PSV ICA lt. = 2.36 m/s) -
  → the same stenoses?
CASE REPORT 3
the study of the flow velocity distal to the stenosis is recommended in these moderate/severe stenosis?

YES

RECOMMENDATIONS
Velocity measurements in a stenosis (PSV and carotid ratio) alone are not sufficient to differentiate a moderate from a severe (≥70% NASCET) stenosis with sufficient clinical reliability.

It is recommended that, in addition, a search for collateral flow is made in the ophthalmic artery branches or the anterior cerebral artery.

Furthermore, it is recommended that the poststenotic flow velocity distal to flow disturbances is examined, in which a reduction of velocities (comparison with the unaffected contralateral side or absolute reduction) allows additional grading within the category of severe stenosis.

*Grading Carotid Stenosis Using Ultrasonic Methods. Stroke. 2012*
CASE REPORT 3: BILATERAL ICA SEVERE STENOSIS
(the flow velocity distal to the stenosis allows additional grading in severe stenosis)

- bilateral ICA stenosis: PSV ICA rt. = 2.59 m/s; ICA lt. = 2.36 m/s (=70% NASCET)
- lt. siphon, distal to the stenosis: poststenotic parvus flow (PSV = 0.56 m/s; IR=0.48)
- rt. siphon flow: regular flow (PSV = 1.25 m/s; IR=0.57)
- presence of collateral supply via anterior communicating artery (rt.→lt.)
- ACM with asymmetric velocity flows (lt. PSV = 0.71 m/s; rt. PSV = 1.90 m/s)
**CASE REPORT 3: BILATERAL ICA SEVERE STENOSIS**

In this case the ICA PSV are similar (rt. = 2.59 m/s; lt. = 2.36 m/s).

**BUT ARE ALSO PRESENT:**

a) the reduction of the ICA/siphon lt. flow velocity (compared with the contralateral side)
b) the presence of collateral supply via anterior communicating artery (rt→lt)
c) the low ACM lt flow (compared with ACM rt. flow)
CASE REPORT 3

In this case the ICA PSV are similar, **BUT**

a) the reduction of the ICA/siphon lt. flow velocity; b) the presence of collateral supply (rt→lt); c) the low ACM lt flow

**mean a more severe stenosis on the lt. side (collateral flow is the most powerful criterion)**
CONCLUSIONS

1. Grading of carotid stenosis by diagnostic US should be primarily based on morphological information and velocity measurements.

2. PSV and carotid ratio alone are not sufficient to differentiate a moderate from a severe (≥70% NASCET) stenosis with sufficient clinical reliability.

3. In these cases, it is recommended the study of:
   a) the poststenotic flow velocity distal to flow disturbances;
   b) the collateral flow in the ophthalmic artery branches or the anterior/posterior cerebral artery.