Carotid Artery Stenosis
Making Complex Assessments of a Simple Problem or Simplifying Approach to a Complex Disease?

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Ever since carotid stenosis measurements were developed to aid randomized clinical trials of carotid endarterectomy, a single number was introduced as an index of the disease severity.¹–⁴ A simple yet accurate noninvasive assessment of internal carotid stenosis remains an evolving goal for ultrasound, CT, and MR.⁵ Area estimates derived from biplane angiograms were replaced by diameter reduction calculations on a single plane showing the most severe narrowing for NASCET grading.² Duplex ultrasound peak systolic velocity has been and continues to be the most common criterion for ultrasound,⁶ despite advances in grayscale imaging and color Doppler technology and individual laboratories utilizing alternate criteria such as internal to common carotid ratios and end-diastolic velocity and ratios. CTA offers absolute residual lumen measurement and NASCET-type measurements but is yet to be recognized as a complete alternative to catheter angiography.⁷–⁹ Even catheter angiography using NASCET measurements has critics.³,¹⁰

Given the heterogeneity of the shape and severity of carotid lesions, their pathophysiology and the technical issues of producing an adequate ultrasound examination, it is no surprise, then, that a simple measurement of the peak systolic velocity at the internal carotid artery stenosis cannot grade all patients. The need to arrive at some consensus and to recommend a more unified approach led to the European publication by de Bray and Glatt in 1995,¹¹ the Society of Radiologists in Ultrasound Multi-Disciplinary Consensus Panel in 2003,⁶ and a United Kingdom working group document in 2008.¹² Details of a single institution clinical trials standard was also recently published by the University of Washington Ultrasound Reading Center.¹³ Society of Radiologists in Ultrasound Multi-Disciplinary Consensus Panel managed to agree on a set of criteria to grade a short-length unilateral carotid artery stenosis⁶ that has been adopted by many Intersocietal Commission for Accreditation of Vascular Laboratories-accredited laboratories (Heather Gornik, MD, personal communication), but its acceptance is far from mainstream.

This new consensus from the Neurosonology Research Group of the World Federation of Neurology codifies a sonographic diagnosis using a combination of criteria including local hemodynamic parameters (the peak systolic velocity and end-diastolic velocity) and upstream and downstream measurements (including waveforms obtained immediately downstream as well as distant from the local disease in ophthalmic or intracranial arteries).¹⁴ Other consensus groups have also addressed the strengths and weakness of duplex ultrasound, offered primary and alternate criteria, and discussed difficulties attributable to long lesions, tandem lesions, contralateral disease, and heterogeneity of techniques such as varying Doppler angles.⁶,¹³ The recognition that a comprehensive evaluation goes beyond the peak systolic velocity to diagnose and grade a stenosis also is not new. Evaluations of lesions before, during, and after a stenosis are found in the American Institute of Ultrasound in Medicine/ American College of Radiology and Intersocietal Commission for Accreditation of Vascular Laboratories guidelines.¹⁵,¹⁶ However the Neurosonology Research Group of the World Federation of Neurology guidelines combine these criteria more formally than most others have before.

The criteria chosen by the Neurosonology Research Group of the World Federation of Neurology offers a new way to combine ultrasound results. The approach is created by consensus and experience rather than a result of a clinical trial. Although many articles suggest combining criteria can give better results, few studies actually demonstrate the value of this approach.¹⁷,¹⁸ As one increases the number of criteria to define categories of the disease as described in this consensus document, what happens to sensitivity and specificity? Will the screening test perform any better? This approach may lead to better positive predictive values, but it can potentially reduce sensitivity dramatically. Sensitivity is limited by the least sensitive test. A criterion chosen for its high specificity without a sufficiently high sensitivity may be acceptable if analyzed alone but may cause unanticipated results when combined with other criteria.

Self-assessment and validation of any adopted diagnostic criteria is the mainstay of the accreditation process vascular ultrasound labs in the United States. Caution should be advised if any recommended criteria are applied without a self-assessment study because it is necessary to determine if the newly adopted criteria perform as well or better than the ones currently in place at any given individual laboratory.
The authors’ suggestion to expand criteria by evaluating poststenotic patterns and collateral flow/transcranial ultrasound findings rightly stresses the need to utilize the much broader information that ultrasound provides. Clinicians as well as stroke researchers should be made aware of these advantages.

This new consensus guideline to move beyond the peak systolic velocity and to combine criteria makes some excellent points. But even allowing for the absence of any prospective validation trials utilizing these criteria, there are other issues. There are no clear-cut rules to arbitrate discordant results from different criteria. Moreover, many, if not most, sites performing duplex ultrasound in the United States still do not have a means to perform transcranial or ophthalmic Doppler at the time of the carotid examination. A universal acceptance of any recommended criteria will remain an elusive goal without a prospective controlled (perhaps even multinational) study verifying improved performance of such criteria and subsequent endorsement by local regulatory authorities as well as various professional societies.

**Disclosures**

None.

**References**

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