Letters to the Editor

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NASCET and ECST: Identifying Clinically Relevant Carotid Disease

In their recent editorial,1 Drs Ackerman and Candia state: "The North American Symptomatic Carotid Endarterectomy Trial (NASCET) has convinced skeptics that identifying and operating on appropriately severe common carotid bifurcation lesions can lead to a risk reduction for stroke."

As one of the Co-Principal Investigators in NASCET, I write to point out that the European Carotid Surgery Trial (ECST),2 which began before NASCET and has worked with us in an unselfish, international collaboration, shares the credit for convincing skeptics about the efficacy of endarterectomy in high-grade symptomatic carotid stenosis.

Although their method for measuring stenosis differs from ours, their pioneering effort should be recognized in establishing the benefits of this procedure.

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References

Doppler Ultrasound Measurement of Cerebral Blood Flow

The recent attempt by Schöning et al1 to measure cerebral blood flow by using duplex ultrasound is a timely reminder of the many limitations of this technique.2 We feel, however, that their article fails to acknowledge how great the errors in their measurements really are.

As the authors note, even minor errors in the measurement of lumen diameter or blood-flow velocity can result in large errors in the calculation of flow volume. For example, the stated 4.1-mm diameter of the external carotid artery is likely to be measured from the ultrasound image with an absolute precision of only ±1 mm (not the 0.1 mm assumed by the authors). This factor alone induces an error of ±50% in the flow value.

The Doppler angle measurement made by the authors assumes that flow is parallel to the vessel wall. In fact, the "off-axis" angle of carotid flow is known to be approximately 20° at the origin of the ICA.3 The consequent error is dependent on Doppler angle, which the authors omit to report, but at an angle of 60° a 20° uncertainty results in a ~65% to ~23% error,4 again not considered by the authors. With any such measurement, accuracy is the combined effect of both systematic error and random variation in the measurement. In the absence of a gold standard measurement, the latter can be assessed by statistical analysis of repeated measurements and the former by physical analysis, such as computer modeling. The authors, it would appear, have attempted to do neither.

There are many other inherent problems with measuring mean flow velocity with duplex ultrasound. These include the small width of the insonating beam (kept narrow in most duplex systems to maintain image resolution) and problems with shift in the main Doppler frequency (due to high-pass characteristics of the receiver and frequency-dependent tissue attenuation).5

The unfortunate use of color duplex (rather than duplex-pulsed Doppler) by the authors compounds these problems. The current technology used to produce a color image represents a fundamental compromise between spatial resolution and velocity resolution (ie, the optimal length of the Doppler pulse), with the balance usually in favor of spatial resolution. The result is that color velocity estimates are less reliable (ie, have a higher variance) than those from spectral pulsed Doppler.6

The result of these methodological shortcomings is that there were substantial differences in flow between the CCA and the ICA+ECA. Despite the use of correlation coefficients, no data are given that will indicate the accuracy of an individual measurement.7 Yet it is precisely this measurement that is used clinically. It would therefore not be possible to calculate with any relevant accuracy the pressure gradient across a carotid stenosis or to provide accurate serial assessment of changes in arterial flow in patients with brain trauma or subarachnoid hemorrhage.

Although the calculation of volume flow by duplex is subject to more than just "minor errors," several new developments have occurred that may provide the solution to these technical problems. These include "time domain" methods that track the acoustic speckle patterns from moving blood (giving a velocity profile that yields the functional size of the lumen as well as total flow)8 and "attenuation-compensated" methods in which the volume of blood is measured directly from the power of the back-scattered Doppler signal itself (thus eliminating the need to measure lumen size or even Doppler angle).9 The sooner we are able to take advantage of these direct methods, the greater will be our clinical understanding of the complexities of cerebral blood flow.

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Doppler ultrasound measurement of cerebral blood flow.
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