REFERENCES

1. Ouriel K, Green RM, DeWeese JA. Anomalous carotid-basilar anastomoses in cerebrovascular surgery. J VASC SURG 1988;7:774-7.
2. McCartney SF, Ricci MA, Labreque P, Symes JF. Artère hypoglosse persistante et endartériectomie carotidienne. Ann Chir Vasc 1989;3:257-60.
3. Osgood CP, Montanez JA, Karunaratne ER, Vandevander DJ. Endartectomy for atheromatous hypoglossal artery. J Neurosurg 1983;58:935-6.

24/41/64197

A simple screening method for peripheral arterial occlusive disease

To the Editors:

It is well known that peripheral arterial occlusive disease (PAOD) is an independent risk factor for cardiovascular morbidity and death. In addition, we have shown that the risk of death is significantly increased even with asymptomatic PAOD.[1] The results of a recently published epidemiologic study, in which the accuracy of a simplified screening method has been determined, will be of interest to vascular surgeons.[2]

Segmental pressures at five different levels and Doppler flow velocities (femoral and posterior tibial artery) have been analyzed in 421 normal subjects and 63 patients with PAOD (diagnosed on the basis of previously established criteria confirmed by angiography). The posterior tibial flow velocity showed the highest sensitivity, specificity, positive and negative predictive values, and overall accuracy of any single parameter. In addition, an absent or audible but not recordable posterior tibial artery velocity signal combined with an ankle/arm pressure ratio of 0.8 or less yielded the highest overall accuracy (98%) with a sensitivity of 89%, specificity of 99%, positive predictive value of 90%, and negative predictive value of 99%.

These results indicate that the vast majority of PAOD cases can be identified with the described combination of ankle, arm pressure, and posterior tibial artery velocity determination, with only a hand-held Doppler velocity meter.

A. Fronek, MD, PhD
Department of Surgery-0643
University of California, San Diego
9500 Gilman Dr.
La Jolla, CA 90203

M. H. Criqui, MD, MPH
H. S. Feigelson, MPH
Department of Family & Preventative Medicine-0607

REFERENCES

1. Criqui MH, Langer RD, Fronek A, et al. Mortality over a period of 10 years in patients with peripheral arterial disease. N Engl J Med 1992;326:381-6.
2. Feigelson HS, Criqui MH, Fronek A, et al. Screening for peripheral arterial disease: the sensitivity, specificity and predictive value of noninvasive tests in a defined population. Am J Epidemiol 1994;140:526-34.

24/41/64198

Reappraisal of methods to measure carotid artery stenosis

To the Editors:

Neale et al.[1] compared duplex criteria to angiographic stenosis measured by the North American Symptomatic Carotid Endarterectomy Trial (NASCET) and European Carotid Surgery Trial (ECST) techniques. The authors conclude that vascular laboratories should validate the duplex criteria they use against a standard angiographic method with reference to NASCET and ECST results. However, Neal et al.[1] do not recommend either of these methods and do not specify how duplex validation should be performed.

There are three methods for measuring carotid artery stenosis on angiograms (Fig. 1). The tightest residual lumen is measured and then compared with the far-distal internal carotid artery (NASCET), an imaginary outline of the carotid bulb (ECST), and the common carotid artery diameter. The last method is called the Carotid Stenosis Index (CSI).[2] The reproducibility, accuracy, and applicability of these methods are different. Neale et al.[1] claim that the NASCET method is more reproducible than ECST because interobserver correlation was better for NASCET ($r = 0.98$) than for ECST ($r = 0.91$)[1]; however, no further data are provided to support this statement. The standard statistical measurement of reliability is the interclass correlation coefficient (ICC). In a study of 130 bifurcations, ICCs were 0.81 (NASCET), 0.86 (ECST), and 0.89 (CSI). NASCET was the least reproducible method, allowing interobserver variation up to 30%, ECST had interobserver variation up to 19%, and CSI had interobserver variation up to 15% (95% confidence intervals).[2] This variation may partly explain the differences in correlation of duplex criteria and angiographic measurements found by Neal et al.[1]

The accuracy of any method can be confirmed by a comparison of angiographic measurements to measurements made on the intact, surgically removed plaque (which can be considered the "gold" standard). Linear angiographic measurements are converted to area derivations and then compared with the planimetry of the intact specimen. In 30 patients, the stenosis index by NASCET was 83.5% ± 12.1%, which significantly underestimated anatomic stenosis (95.9% ± 3.9%, $p < 0.001$). ECST and CSI were more accurate (94.5% ± 7.0% and 93.2% ± 10.2%, ns).[2]

The clinical applicability of these methods was studied on consecutive patients who underwent angiography to determine the degree of carotid artery stenosis. In a study of 165 consecutive angiograms (330 bifurcations),[3] 20% of carotid arteries were normal, 10% were occluded, and 70%

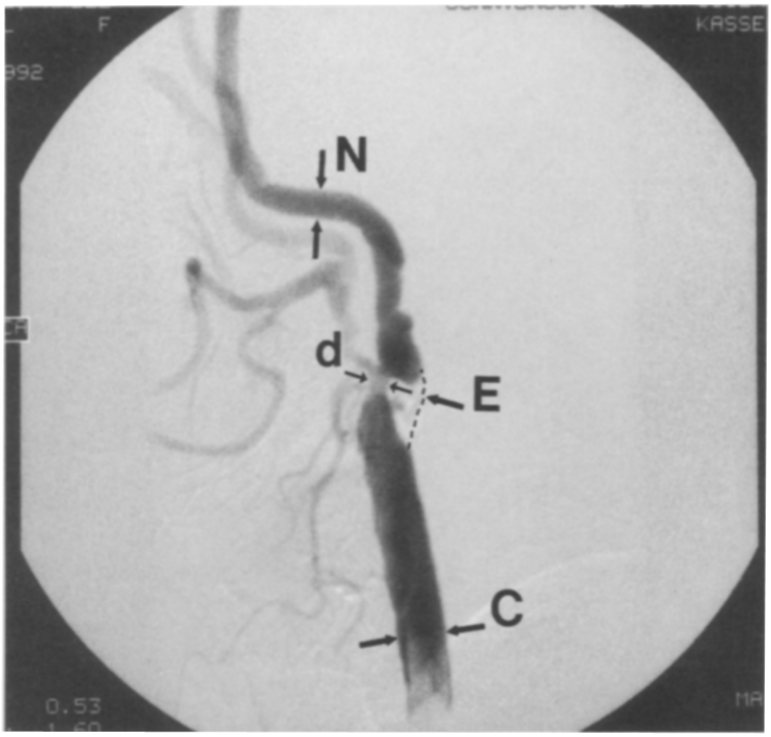

Fig. 1. Angiographic methods of measuring carotid artery stenosis. Stenosis = 1 − d/n) × 100%, where *d* represents residual lumen, and *n* is measured at following locations: *N* represents far-distal ICA (NASCET); *E* represents imaginary outline of carotid bulb (ECST); *C* represents CCA 3 to 5 cm below bifurcation (CSI). To estimate normal width of carotid bulb, proximal CCA should be multiplied by 1.2; coefficient was modified from Williams MA, Nicolaides AN. Predicting the normal dimensions of the internal and external carotid arteries from the diameter of the common carotid. Eur J Vasc Surg 1986;1:91-6.

had stenoses ranging from 10% to 99%. When normal and occluded vessels were excluded, NASCET was inapplicable in 30% of the remaining because of overlying vessels attenuating the view of far-distal internal carotid artery (ICA), poor opacification of poststenotic ICA, or the presence of two segments with parallel walls suitable for measurement but with significantly different diameters. These limitations make the NASCET method the most operator-dependent and least accurate, and thus inapplicable in this particular subgroup of patients. With minor degrees of carotid bulb atherosclerosis, the residual lumen is wider than the distal ICA, which causes the NASCET stenosis index to be negative (e.g., −28%). This makes comparison of the NASCET scale and duplex scanning difficult, particularly in the mild to moderate stenosis groups. ECST and CSI do not have these disadvantages and are applicable to more than 90% of angiograms. Neale et al.[1] did not specify how many bifurcations were normal or occluded or had mild, moderate, or severe stenosis, which makes their data less generalizable.

Both NASCET and ECST are valuable indexes for surgical decisions. The evidence indicates, however, that a common carotid artery (CCA) denominator is also a reliable predictor of the surgical benefit.[4] A simple conversion may be used to compare the three methods:[2,3] 70% NASCET = 82% CSI = 84% ECST, and 30% NASCET = 55% to 60% CSI = 55% to 60% ECST.

It is important to have valid duplex criteria to minimize false-negative and false-positive results when ultrasonography is used for screening for significant stenosis. Discrepancies between observers in determining angiographic stenosis are not resolved by the opinion of a senior radiologist,[1] but rather by use of an accurate method with high reproducibility. The CSI avoids the limitations of the NASCET and ECST methods by use of a more reliable denominator, the CCA. To develop duplex criteria the CSI method may be used for comparison of ultrasound data with angiographic measurements in consecutive patients undergoing both duplex scanning and angiography. The use of the method on the basis of the CCA measurement is also supported by data that the greatest accuracy of duplex scanning can be obtained when peak systolic ICA velocities are also related to the velocities in the CCA.[1,5]

Andrei V. Alexandrov, MD
Patrick M. Pullicino, MD, PhD
Western New York Neuroscience Center
Buffalo General Hospital
Buffalo, NY 14203

REFERENCES

1. Neale ML, Chambers JL, Kelly AT, et al. Reappraisal of duplex criteria to assess significant carotid stenosis with special reference from the North American Symptomatic Carotid Endarterectomy Trial and the European Carotid Surgery Trial. J VASC SURG 1994;20:642-9.
2. Bladin CF, Alexandrov AV, Murphy J, Maggisano R, Norris JW. The Carotid Stenosis Index (CSI)—a new method of measuring carotid artery stenosis. Stroke 1995;26:230-4.
3. Alexandrov AV, Bladin CF, Murphy J, Hamilton P, Maggisano R. Clinical applicability of methods to measure carotid stenosis. J Stroke Cerebrovasc Dis 1994;4:258-61.
4. Rothwell PM, Gibson RJ, Slattery J, Warlow CP. Prognostic value and reproducibility of measurement of carotid artery stenosis: a comparison of three methods on 1001 angiograms. Stroke 1994;25:2440-4.
5. Moneta GL, Edwards JM, Chitwood RW, et al. Correlation of North American Symptomatic Carotid Endarterectomy Trial (NASCET) angiographic definition of 70% to 99% internal carotid artery stenosis with duplex scanning. J VASC SURG 1993;17:152-9.

24/41/64480

Reply

To the Editors:

We thank Drs. Alexandrov and Pullicino for their interesting comments relevant to our study. We did not compare a measurement of carotid artery stenosis based on comparing the residual internal carotid artery (ICA) diameter to the common carotid artery (CCA) diameter as defined by the Carotid Stenosis Index (CSI).[1] Our aim was to compare two commonly used duplex criteria with the two most commonly used methods of measuring angiographic stenosis (recently highlighted in the European Carotid Surgery Trial [ECST][2] and the North American Symptomatic Carotid Endarterectomy Trial [NASCET][3]) to assess in our unit how well the duplex and angiographic findings correlate.

Seventy-five of 120 carotid bifurcations in our series (63%) showed stenosis ranging from 10% to 99% (not dissimilar to the 70% reported by Dr. Alexandrov[4]). We were surprised to find that in our series the duplex criteria based on Strandness et al.[5] correlated better with the angiographic method as used in the NASCET, even though these criteria were originally developed with the angiographic measurement as used in the ECST. In keeping with the recommendations of the Committee on Standards for Noninvasive Vascular Testing of the Joint Council of the Society for Vascular Surgery and North American Chapter of the International Society for Cardiovascular Surgery, angiographic reporting in our unit has been based on measurement of ICA stenosis with reference to the distal ICA. With the use of selective digital subtraction angiography carotid catheterization and multiple views, obtaining a view of the ICA without attenuation from overlying vessels has not been a significant problem.

Although the angiographic method used in the ECST has been reported to be more reproducible than that used in NASCET, others have found NASCET to be more reproducible. It should be emphasized that the absolute differences (± SD) between observer measurements for both the NASCET, and ECST methods of angiographic assessment in our series were small (3% ± 5.2% and 4.5% ± 6.3%, respectively), suggesting that the reproducibility of these methods is in fact very similar. It must also be remembered that neither measurement is a true representation of actual lumen area stenosis but represents a percent diameter stenosis as seen on the angiogram. Similarly, the recognized underestimation of true stenosis with use of the NASCET method must also be remembered. However, no difference has been reported between the NASCET, ECST, or CSI methods when used as a prognostic indicator of ipsilateral ischemic stroke.[8] The prognostic value of each method is ultimately of greatest clinical interest.

Because the indications for carotid endarterectomy are being better defined, there is a greater need for reliable methods of assessing ICA stenosis, and some uniformity of reporting standards seem desirable. The variability of measurements with duplex scanning between different laboratories and duplex scanners must, however, be emphasized. The duplex criteria used should be critically evaluated by individual units. The CSI may indeed prove to be a useful method of comparing duplex scanning and angiography. We look forward to seeing further results of this method of angiographic assessment.

Michael Neale, MBBS
Michael Applebery, FCS(SA), FRACS, DDU
Department of Vascular Surgery
Royal North Shore Hospital
St. Leonards 2065
Sydney, NSW
Australia

REFERENCES

1. Bladin CF, Alexandrov AV, Norris JW. How should we measure carotid stenosis? Lancet 1994;344:69(Letter).
2. European Carotid Surgery Trialists' Collaborative Group. MRC European Carotid Surgery Trial: interim results for symptomatic patients with severe (70% to 99%) or with mild (0% to 29%) carotid stenosis. Lancet 1991;337:1235-43.
3. North American Symptomatic Carotid Endarterectomy Trial Collaborators. Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. N Engl J Med 1991;325:445-53.
4. Alexandrov AV, Bladin CF, Murphy J, et al. Clinical applicability of methods to measure carotid stenosis. J Stroke Cerebrovasc Dis 1994;4:258-61.
5. Strandness DE Jr. Duplex scanning in vascular disorders. New York: Raven Press Ltd, 1990:92-120.

24/41/64479

Regarding "Arterial injuries in the thoracic outlet syndrome"

To the Editors:

The excellent and comprehensive study by Durham et al. (J VASC SURG 1995;21:57-69) reminded me of happy