Clinical Implications of the Vascular Laboratory in the Diagnosis of Cerebrovascular Insufficiency

Ali F. AbuRahma

Introduction

Stroke, the third leading cause of death in the United States, disables nearly 2 million people yearly, resulting in the cost of many millions of dollars. Eighty percent of strokes are caused by cerebral infarction rather than hemorrhage. About 75% of patients with ischemic cerebrovascular disease have at least one obstructing lesion at a surgically accessible site, most frequently the carotid artery bifurcation.

In a recently reported North American Symptomatic Carotid Endarterectomy Trial (NASCET), surgery was highly beneficial in patients with recent hemispheric transient ischemic attacks or mild strokes and 70–99% stenosis of the ipsilateral internal carotid artery.1 Because of this striking difference in favor of carotid endarterectomy over medical treatment (27% versus 9% at 18 months), it was recommended that patients with symptomatic stenosis of equal to or greater than 70% be considered for surgery. At the Stroke Council Meeting of the American Heart Association held in Orlando, Florida in February, 1998, it was reported that patients with symptomatic internal carotid artery stenosis of equal to or greater than 50–70% also had better results with carotid endarterectomy than with medical therapy. Similar conclusions were reached by the European Carotid Surgery Trialists’ Collaborative Group.2 The benefit of carotid endarterectomy for asymptomatic high-grade stenoses (equal to or more than 60%) of the internal carotid artery was also demonstrated by the recent results of the Asymptomatic Carotid Atherosclerosis Study (ACAS).3

The various noninvasive tests for the evaluation of cerebrovascular insufficiency have been described in previous chapters. Virtually all forms of noninvasive testing pose less stress and less expense to the patient than angiography. While early forms of noninvasive testing depended on the presence of severe disease, the current techniques, especially carotid artery imaging, demonstrate the opposite characteristic. Carotid imaging is able to detect minimal disease that is not hemodynamically significant; in fact, overestimation of the degree of stenosis in these cases has been a consistent problem. Nevertheless, any test intended for screening must have a high degree of sensitivity to be used appropriately in the initial assessment of disease. Noninvasive assessment, therefore, combines low risk, low cost, and high sensitivity.

Although we agree that patients should be evaluated by careful history and physical examination, our policy tends to rely on noninvasive vascular testing as an initial step in the diagnosis of carotid artery disease. The results of noninvasive tests may also help in obtaining optimal angiograms. An example is the patient with noninvasive evidence of
severe stenosis who has no significant stenosis demonstrated in standard views of the carotid artery bifurcation. The results of the noninvasive tests indicate the need for additional projections, and if the bifurcation region does not show the expected lesion, there is a strong indication for obtaining adequate siphon views.

Prior to the advent of digital techniques, standard angiograms were routinely used in the evaluation of patients with cerebral ischemic attacks in order to determine whether vascular reconstructive surgery was indicated. Standard angiography was of limited clinical value, particularly as a means of diagnostic screening in asymptomatic patients, because of prohibitive costs, poor patient acceptance, and the risk of arterial catheterization. As a result, noninvasive vascular tests became established as the preferred means of diagnostic screening in asymptomatic patients, because they provided an objective method of determining the hemodynamic significance of carotid disease in a safe and relatively cost-efficient manner.

Recent studies have questioned the role of arteriography as the “gold standard” in the evaluation of carotid artery occlusive disease. Contrast arteriography has also been noted to have a 1–4% incidence of neurologic complications with about a 1% incidence of stroke reported in the ACAS study. Other complications of arteriography that were reported include complications at the arterial puncture site (5%), and contrast-induced renal dysfunctions in 1–5%. With this in mind, it would be beneficial and cost-effective if these patients could be safely evaluated without invasive arteriography. Duplex ultrasonography (with or without color) of the carotid arteries and magnetic resonance angiography (MRA) are two noninvasive modalities that can detect and grade carotid artery stenosis.

**Carotid Angiography, Magnetic Resonance Angiography, and/or Color Duplex Ultrasound in the Diagnosis of Carotid Artery Disease (Single or Combined)**

Carotid duplex ultrasound is readily available, noninvasive, inexpensive, fast, repeatable with good resolution of carotid plaque morphology, and has excellent accuracy in most experienced medical centers. Its two chief limitations are that it does not provide a three-dimensional image of the blood vessel, and that there is no suitable acoustic access to certain vessels of interest in the body. For example, it cannot directly visualize the origin of the left carotid artery, the distal internal carotids, or the circle of Willis (Fig. 12.1). Therefore, a screening examination based on ultrasound alone may be incomplete for certain surgical patients. Ultrasound is also highly operator-dependent, with a skilled technologist providing more reliable information than the novice.

The weaknesses of color duplex ultrasound as a noninvasive screening examination are complemented by magnetic resonance angiography. Magnetic resonance angiography is also a noninvasive modality and can access virtually any place in the body (e.g., the carotid artery from the arch to the circle of Willis), and is not obscured by over-

![Fig. 12.1. Four-vessel arch aortogram showing tight stenosis at the origin of the left common carotid artery (open arrow), a tight stenosis of the right vertebral artery (straight arrow) and a tight stenosis of the left vertebral artery (curved arrow) which originates from the arch of the aorta.](image-url)