Management of Extracranial Carotid Artery Disease

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KEYWORDS

• Carotid disease • Carotid stenosis • Atherosclerotic disease • Stroke • Carotid endarterectomy • Carotid angioplasty and stenting • Antiplatelet therapy

KEY POINTS

- Asymptomatic patients without risk factors should not be screened for carotid atherosclerotic disease.
- Carotid ultrasonography should be the initial screening tool for symptomatic patients.
- Medical management, including antiplatelet therapy, is indicated in all symptomatic patients with carotid atherosclerotic disease, independent of degree of stenosis.
- In general, carotid revascularization is indicated in symptomatic patients with nonocclusive moderate to severe stenosis (>50%) and asymptomatic patients with severe stenosis (>70%).
- When revascularization is indicated, patient anatomy, risk factors, and plaque factors should be considered in the decision for carotid endarterectomy versus angioplasty and stenting.

INTRODUCTION

Epidemiology

When considered as an independent diagnosis separate from other cardiovascular diseases, stroke is the third leading cause of death in developed nations and a leading cause of long-term disability.[1] Approximately 87% of all strokes are ischemic, 10% are hemorrhagic, and 3% are subarachnoid hemorrhages.[2–10]

Based on the Framingham Heart Study and Cardiovascular Health Study populations, the prevalence of greater than 50% carotid stenosis is approximately 9% in men and 6% to 7% in women.[11,12] Carotid stenosis or occlusion as a cause of stroke has been more difficult to determine from population studies. Approximately 7% to 18% of all first strokes were associated with carotid stenosis.[13,14] The risk for recurrent strokes among survivors is 4% to 15% within a year after the initial stroke, and 25% by 5 years.[8]

Extracranial atherosclerotic disease accounts for up to 15% to 20% of all ischemic strokes.[15,16] Whereas intracranial atherosclerotic disease has been shown to be consistently more common among Blacks, Hispanics, and Asians in comparison with Whites,[15,17] the racial differences for extracranial atherosclerotic disease are less apparent. The Northern Manhattan Stroke study reported equal incidence of extracranial atherosclerotic disease among patients of all races presenting with an acute ischemic stroke.[15] However, a smaller study reported that Whites were

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more likely than Blacks to have extracranial carotid artery lesions (33% vs 15%, $P = .001$).[16] Male gender appears to be an independent predictor for intracranial atherosclerotic disease, whereas no gender differences were reported for extracranial disease.[16]

Natural History

Stroke associated with extracranial carotid atherosclerotic disease could occur via several mechanisms[18]:

- Atheroembolism of cholesterol crystals or other debris
- Artery to artery embolism of thrombus
- Structural disintegration of the wall (dissection)
- Acute thrombotic occlusion
- Reduced cerebral perfusion with plaque growth

In symptomatic patients, there is a clear correlation between the degree of stenosis and the risk of stroke.[19] In the North America Symptomatic Carotid Endarterectomy Trial (NASCET), the stroke rate after 18 months of medical therapy without revascularization was 19% in patients with 70% to 79% stenosis, 28% in patients with 80% to 89% stenosis, and 33% in patients with 90% to 99% stenosis.[19]

This correlation is less apparent in asymptomatic patients. In the Asymptomatic Carotid Atherosclerosis Study (ACAS) and the Asymptomatic Carotid Surgery Trial (ACST), asymptomatic patients with 60% to 80% stenosis had higher strokes rates compared with those with more severe stenosis.[20,21] The presence of a carotid bruit also does not appear to be a reliable predictor of stroke risk in asymptomatic patients. Despite the Framingham Heart Study population showing that asymptomatic patients with carotid bruit had a 2.6-fold increased incidence of strokes in comparison with those without carotid bruit, less than half of these stroke events involved the ipsilateral cerebral hemisphere.[3]

Although the degree of carotid stenosis remains the main determinant of disease severity, additional imaging markers of plaque vulnerability are also important in determining the risk for transient ischemic attack (TIA) and strokes.[22–24] Imaging markers for plaque vulnerability on ultrasonography (US) include[22,23]:

- Ulceration
- Echolucency
- Intraplaque hemorrhage
- High lipid content

Thin or ruptured fibrous caps, intraplaque hemorrhage and large lipid-rich or necrotic plaque cores, and overall plaque thickness seen on MRI have also been associated with subsequent ischemic events.[25]

The utility of biomarkers and imaging makers for inflammation in predicting plaque vulnerability and the risk for stroke has also been investigated. Carotid plaques from patients with ipsilateral stroke demonstrated infiltration of the fibrous cap by inflammatory cells.[26,27] ^{18}F-Fluorodeoxyglucose measured by PET is believed to reflect inflammation.[28,29] Macrophage activity quantified by PET has been observed in experimental models. In addition, biomarkers such as C-reactive protein and different matrix metalloproteinases are currently being studied for their predictive value of plaque instability.[30–32] However, the reliability of these markers remains uncertain.

EVALUATION OF CAROTID ATHEROSCLEROTIC DISEASE

Carotid Ultrasonography

When performed by well-trained, experienced technologists, carotid US is accurate and relatively inexpensive.[33–38] Carotid US is also noninvasive, and does not require a venipuncture or exposure to contrast material or radiation. As such, carotid US is recommended for the initial evaluation of symptomatic and asymptomatic patients with suspicion for carotid atherosclerotic disease.[39]

Carotid US should be performed in asymptomatic patients with 2 or more of the following risk factors:

- Hypertension
- Hyperlipidemia
- Family history of atherosclerosis or ischemic stroke before 60 years of age
- Tobacco smoking

US remains an appropriate screening tool for high-risk, asymptomatic patients irrespective of auscultation findings, because the sensitivity and positive predictive value of a carotid bruit for a hemodynamically significant carotid stenosis are relatively low.

Carotid US is not recommended, however, for routine screening of asymptomatic patients without risk factors for atherosclerotic disease, owing to the lack of data from health economic studies to support mass screening of the general population.[40,41]

Carotid US should also be performed annually to assess the progression or regression of disease and response to therapeutic measures in patients with greater than 50% stenosis. Once stability has