



Evaluation and Management of Atherosclerotic Carotid Stenosis

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CME Activity

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Statement of Need: General internists and primary care physicians must maintain an extensive knowledge base on a wide variety of topics covering all body systems as well as common and uncommon disorders. *Mayo Clinic Proceedings* aims to leverage the expertise of its authors to help physicians understand best practices in diagnosis and management of conditions encountered in the clinical setting.

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Learning Objectives: On completion of this article, you should be able to (1) review current strategies and recommendations for diagnosis and management of carotid artery disease; (2) recognize the various methods for assessing carotid stenosis; (3) understand and apply various proven medical methods for reducing the risk of stroke in patients with carotid artery atherosclerosis; and (4) interpret clinical factors that influence the decision whether to choose endarterectomy or stenting for revascularization of carotid stenosis

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Abstract

Medical therapies for the prevention of stroke have advanced considerably in the past several years. There can also be a role for mechanical restoration of the lumen by endarterectomy or stenting in selected patients with high-grade atherosclerotic stenosis of the extracranial carotid artery. Endarterectomy is generally recommended for patients with high-grade symptomatic carotid stenosis. Stenting is considered an option for patients at high risk of complications with endarterectomy. Whether revascularization is better than contemporary medical therapy for asymptomatic extracranial carotid stenosis is a subject of several ongoing randomized clinical trials in the United States and internationally.

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Atherosclerosis is not merely a by-product of the sedentary lifestyle and adverse dietary habits typical of the 21st century, because it has afflicted humanity for millennia. A whole-body computed tomographic study of mummies found that

about one-third of preindustrial populations, including preagricultural hunter-gatherers, had evidence of atherosclerosis.¹ Atherosclerosis is common in the modern asymptomatic middle-aged population. In one study of asymptomatic individuals between age 40

and 54 years, nearly one-third had ultrasonographic evidence of atherosclerosis in the carotid arteries.² When the burden of atherosclerosis becomes severe enough to cause stenosis of the carotid artery, it may act as a source of embolism and, by extension, a cause of ischemic stroke. When cerebral infarction or reversible cerebral ischemia occurs in the perfusion zone distal to a carotid stenosis, the carotid stenosis is said to be symptomatic. The risk of future stroke increases with greater degree of stenosis in patients whose stenosis is symptomatic.³ About 8% to 15% of ischemic strokes are attributable to carotid atherosclerosis.⁴⁻⁶ In this narrative review, we summarize the data regarding the evaluation and management of asymptomatic and symptomatic carotid stenosis.

METHODS

This review and our recommendations are supported by a formal search of the medical literature updated since a prior publication on this topic in 2007 in this journal.⁷ The [Appendix](#) describes the specific approach used to identify the relevant medical literature.

IDENTIFYING AND CHARACTERIZING CAROTID STENOSIS

The most common noninvasive ways of screening for carotid stenosis are duplex ultrasonography, computed tomographic angiography (CTA), and magnetic resonance angiography (MRA). In the case of carotid ultrasonography, the degree of carotid stenosis is largely determined by measuring the velocity of blood flow at various segments of the artery. Criteria have been established for translating velocity measurements into clinically useful stenosis cut points.^{8,9} For example, one meta-analysis found a peak systolic velocity of 200 cm/s or greater on ultrasonography to have a sensitivity of 90% and specificity of 94% for diagnosing angiographic stenosis of 70% or more.⁸ However, measurement properties vary considerably among laboratories. Factors that can affect the sensitivity of ultrasonography include heavy calcification of the artery and selected contours of the neck. Distal and proximal segments of the extracranial carotid artery cannot be visualized on ultrasonography.

Computed tomographic angiography generally correlates well with carotid

ultrasonography, although unlike ultrasonography, it exposes patients to radiation and contrast media.¹⁰ With the recent documentation of the efficacy of mechanical thrombectomy for treating acute ischemic stroke in selected patients,¹¹ CTA is being used with greater frequency in the initial evaluation of patients.¹² Thus, patients with nondisabling stroke who are being considered for carotid revascularization may have a CTA available for review.

Catheter angiography traditionally has been considered the criterion standard for stenosis assessment in patients with carotid disease. However, MRA fares well by comparison. A study of 103 patients undergoing endarterectomy had their plaque sectioned transversally and assessed planimetrically.¹³ All patients had preoperative catheter angiography and MRA. Overall, catheter angiography underestimated histologic stenosis by 14.5%, whereas MRA underestimated histologic stenosis by only 0.7%. Among patients with catheter angiography-defined severe stenosis, MRA overestimated stenosis by 12.1%.

The risk associated with modern digital subtraction angiography is low. The rate of permanent neurologic complications is about 0.5%.¹⁴ Rates of transient neurologic complications range from 0% to 2.4%, and rates of major nonneurologic complications range from 0.26% to 4.3%.¹⁵ Nonetheless, there is little justification to expose asymptomatic patients to the risk of catheter-based angiography before treatment decisions.

The cost of carotid imaging should be considered. A prospective study of 167 patients found that the most cost-effective approach to carotid imaging for evaluating patients before endarterectomy was carotid ultrasonography and contrast-enhanced MRA, proceeding to digital subtraction angiography only in cases of discrepancy in which the MRA is positive for high-grade stenosis and the ultrasonography is negative.¹⁶

A challenge regarding the use of revascularization for preventing stroke in patients with asymptomatic carotid stenosis is the generally low risk of stroke in untreated patients. Various imaging techniques are being used and developed to stratify risk of stroke in asymptomatic stenosis. Magnetic resonance imaging (MRI) techniques can be used to characterize plaque

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