EDITORIAL COMMENT

Functional Occlusions of the Carotid Artery (String Signs)

To Treat or Not to Treat?*

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In this issue of JACC: Cardiovascular Interventions, Nikas et al. (1) highlight 2 important issues in carotid disease: What is the appropriate treatment for near total occlusions with collapse of the distal lumen (string signs)? And if revascularization is chosen, what is the appropriate technique?

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Subtotal occlusions with collapse of the distal lumen represent a small but controversial subset of patients with advanced carotid disease. Historically, these patients were treated emergently with carotid endarterectomy, but the findings of the NASCET (North American Symptomatic Carotid Endarterectomy Trial) challenged that assumption. In the NASCET, all patients underwent angiography and had core laboratory review of the angiograms including assessment of collateral circulation. Overall, there was a strong reduction in the risk of stroke at 2 years in patients undergoing carotid endarterectomy versus those treated with medical management. In addition, the benefit was proportional to the degree of stenosis, with patients in the 90% to 99% stenosis category having a greater benefit than patients in the 70% to 79% stenosis category (2).

An initial analysis from the NASCET subdivided the 90% to 99% stenosis group into 90% to 94% stenosis and near occlusion (3). Patients with near occlusions had a lower risk of stroke at 1 year (11%) compared with the 90% to 94% stenosis group (35%). The perioperative risk, however, was similar in the 2 stenosis categories—approximately 6%—so there was no net benefit in favor of surgery for severe stenosis as well as near occlusion. An additional observation was that stroke occurred in the first month in the near occlusion category, so emergent surgery was not indicated.

A later, more detailed angiographic analysis from the NASCET shed some more light on the patients with true string signs as distinguished from near occlusions (4). In this article, detailed angiographic analysis including assessment of the collateral circulation was performed, and importantly, patients with string signs were captured in the category of “severe distal reduction.” Collateral circulation to the affected hemisphere increased with the degree of stenosis, with 42% of patients with 85% to 99% stenosis having collateral circulation versus 64% of the patients with string signs. In medically treated patients, the risk of stroke was significantly less (27.8% vs. 11.3%, p = 0.005) in patients with string signs, which represents a moderate-to-severe level of disability. This is puzzling, because most of the patients are reported as having transient ischemic attacks. Asymptomatic patients had strokes, including 1 acute stroke, with the remainder having transient ischemic attacks. Asymptomatic patients were treated only in the presence of thrombus on angiography. The population was elderly, with the mean age of 70 years and 40% were 80 years of age or older. The mean baseline National Institutes of Health Stroke Scale score is reported as 13.9, which represents a moderate-to-severe level of disability. This is puzzling, because most of the patients are reported as having transient ischemic attacks. Proximal protection was used successfully in all but 1 patient with excellent results with no procedural strokes.

Proximal protection for carotid intervention has a long history and is a direct descendant of carotid clamping performed by surgeons during endarterectomy. Its earliest champion was Jacques Theron in the 1980s. Indeed, in the first carotid angioplasty performed at the University of Alabama in Birmingham by Jiri Vitek and I in 1994, we improvised a proximal occlusion technique by inserting 2 femoral sheaths and placing a peripheral balloon adjacent to the guide catheter to occlude the common carotid artery. Although proximal occlusion was the initial emboli protection technique, it was soon supplanted by distal filters due to ease of use, avoidance of trauma to the arch and common carotid, and lack of brain ischemia. Arch trauma is a particular concern, because up to one-half of all strokes during carotid stenting might be due to carotid access (8–10). String signs can be treated with filter-type emboli protection devices and were not excluded from the...
SAPPHIRE (Stenting and Angioplasty with Protection in Patients at High Risk for Endarterectomy) trial.

Proximal occlusion has become a mainstay for cases at particularly high risk of embolization or in which filter devices cannot be used, such as acute stroke. All of the current acute stroke thrombectomy devices include a proximal balloon occlusion catheter (11). As technology has evolved, proximal occlusion devices have become easier to use and have migrated beyond acute stroke. Proximal occlusion has been used in a wide variety of carotid stenting cases although not randomized against endarterectomy.

The decision to revascularize a patient with a carotid string sign remains complex and should be made after careful deliberation. These patients seem to have a lower risk of stroke most likely due to diminished antegrade flow and the presence of collateral circulation. Most of these patients, particularly asymptomatic patients, do not require revascularization. Therapy, however, should be tailored to the individual patient. Recurrent or crescendo symptoms warrant treatment. Stable or asymptomatic patients who demonstrate a reversible perfusion defect on stress perfusion testing with single-photon emission computed tomography, magnetic resonance imaging, or computed tomography might also benefit from revascularization (Fig. 1). Perfusion imaging is a standard technique in evaluating patients with carotid occlusions who might benefit from extracranial to intracranial bypass surgery (12).

In our practice, recurrent symptoms or a reversible perfusion defect are required before intervention is considered in patients with functional occlusion of the carotid artery. In surgical candidates, symptomatic patients with thrombus are best treated by endarterectomy. Asymptomatic patients with thrombus should also be offered surgery if they are suitable candidates; alternatively, anticoagulation for 6 to 8 weeks is also a reasonable choice before considering revascularization. In patients with string signs requiring carotid stenting, proximal protection is a useful technique and might be preferable to filter-based devices, if the aortic arch and common carotid anatomy are suitable.

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