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*Frank D. Kolodgie, Gaku Nakazawa, Giuseppe Sangiorgi, Elena Ladich, Allen P. Burke, and Renu Virmani*

Atherosclerotic plaque at the carotid bifurcation is the primary cause of ischemic strokes and the degree of carotid stenosis is strongly associated with stroke risk in symptomatic patients. Stroke is the third-leading cause of death in the United States, constituting approximately 700,000 cases each year. In this article, the authors discuss the natural history of carotid and intracranial atherosclerosis, based on their broader knowledge of coronary atherosclerosis. Early to more advanced progressive lesions of the carotid are categorized, based on descriptive morphologic events originally cited for the coronary circulation. The histologic features associated with symptomatic and asymptomatic carotid disease are also addressed, along with the issues surrounding current stent-based therapies for the prevention of major recurrent vascular events.

## Mechanisms of Ischemic Stroke Secondary to Large Artery Atherosclerotic Disease

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*Colin P. Derdeyn*

Atherosclerotic occlusive disease of the cervical and intracranial arteries leads to ischemic stroke through two separate, but interrelated, mechanisms: local thrombosis or embolism from atherosclerotic plaque, and hemodynamic failure (low flow). In this article, the author discusses the evidence linking these two mechanisms with cerebral ischemia, and the evidence for the synergistic effects of thromboembolism and impaired hemodynamics. An understanding of these two mechanisms is important because these

mechanisms provide the rationale for revascularization for patients who have atherosclerotic stenosis or occlusion. In addition, the biologic imaging of atherosclerotic plaques and hemodynamic assessment eventually will play an important role in stratifying patient risk and guiding physiologically based patient selection for intervention.

## **Chronic Ischemia and Neurocognition**

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*Mohamad Chmayssani, Joanne R. Festa, and Randolph S. Marshall*

Cognitive impairment from a major stroke as a consequence of carotid disease is an acknowledged clinical outcome; however, cognitive impairment without major stroke is open to discussion. The three recognized mechanisms for cognitive dysfunction from internal carotid artery are microembolization, white-matter disease, and hypoperfusion. The last has been most difficult to characterize physiologically. In this article, the authors review evidence supporting the existence of chronic ischemia in the brain and its direct impact on cognitive functions. By incorporating the pathophysiology of chronic ischemia into the algorithm of the management of carotid artery disease, we may be able to extend the goals of carotid artery revascularization beyond merely preventing stroke to include preventing or reversing cognitive decline.

## **Extracranial Stenosis: Endovascular Treatment**

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*Yince Loh and Gary R. Duckwiler*

Stroke is the third-leading cause of death in the United States. It occurs in almost 700,000 people per year and cost an estimated \$57.9 billion in 2006. Atherosclerotic disease is the cause of one third of these strokes, with more than one half of these stenoses being extracranial in location. Carotid stenoses are usually unifocal and 90% occur within 2 cm of the carotid bulb. Currently, carotid endarterectomy accounts for 117,000 surgical revascularizations per year, whereas carotid angioplasty and stenting are performed less than 10,000 times annually. Stenoses amenable to revascularization are the topic of this article.

## **Techniques of Carotid Angioplasty and Stenting**

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*Christopher J. Moran, DeWitte T. Cross, III, and Colin P. Derdeyn*

Carotid angioplasty and stenting (CAS) is an alternative technique to restore a normal lumen for patients who are at high risk for adverse effects with carotid endarterectomy (CEA). CAS has been shown to be of benefit to several groups of patients who have carotid disease and who ordinarily are excluded from many CEA trials. Government payors have approved embolic protection devices (EPDs) and stents for the now reimbursable procedure. In fact, the Centers for Medicare and Medicaid Services are now mandating use of the EPDs in CAS to issue payment. The prudent practitioner will carefully select the patients for CAS with EPD and CEA, so that patients will have the safest opportunity to avoid the devastating effects of cerebrovascular accidents.

## **Angioplasty and Stenting for Atherosclerotic Intracranial Stenosis: Rationale for a Randomized Clinical Trial**

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*Colin P. Derdeyn and Marc I. Chimowitz*

Atherosclerotic disease of the major intracranial arteries is a frequent cause of stroke. In addition, many patients who have symptomatic intracranial stenosis are at very high risk for recurrent stroke. Preliminary studies suggest that angioplasty and stenting may

reduce the risk of stroke in patients who have severe stenosis of intracranial arteries. Data for angioplasty and stenting, however, consist of case series; no randomized studies have been completed to date. This article reviews these data and discusses the rationale for a randomized trial of angioplasty and stenting versus best medical management for patients who have symptomatic intracranial stenosis.

### **Technique for Intracranial Balloon and Stent-Assisted Angioplasty for Atherosclerotic Stenosis**

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*DeWitte T. Cross, III, Christopher J. Moran, and Colin P. Derdeyn*

Dilation of stenoses of the major intracranial arteries is now technically possible in many cases. Using proper precautions, most procedures can be performed without complications today, but the safety margin will likely be improved with refinement of current devices and the introduction of new devices made specifically for this indication. Early experience with these techniques is promising for lowering the risk for recurrent ischemic events in patients who have symptomatic intracranial arterial stenosis refractory to medical therapy. This article describes the steps taken to perform transluminal balloon angioplasty and stent-assisted angioplasty for intracranial atherosclerotic stenosis, from patient preparation through follow-up, including procedural steps and device selection.

### **Endovascular Treatment of Vertebral Artery–Origin and Innominate/Subclavian Disease: Indications and Technique**

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*Guilherme Dabus, Christopher J. Moran, Colin P. Derdeyn, and DeWitte T. Cross, III*

Approximately 20% to 40% of patients who have cerebral vascular disease have a vertebral artery–origin stenosis. Atherosclerotic lesions of vertebral artery origin are a potential cause of posterior circulation ischemia, which can be disabling or deadly. Endovascular treatment of vertebral artery–origin and innominate/subclavian artery stenosis has changed in the last 15 years. Surgery usually is successful technically; however, it is also associated with high rates of procedural and periprocedural complications. New techniques and technologies that can be used in the treatment of such lesions are being developed. In this article, the authors discuss the indications, technical aspects, and long-term results of angioplasty and stenting of these vessels.