Vertebral and Intracranial Artery Angioplasty

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Cerebral ischemia is due to either embolic or cerebrovascular occlusive disease, which most commonly occurs as a manifestation of atherosclerosis. Although carotid endarterectomy has been proven more effective than medical therapy in the treatment of cervical carotid disease, there are no effective surgical strategies for the management of vertebral artery or intracranial carotid disease. Management of patients with these conditions is well suited to a multidisciplinary team with the combined skills to provide optimal care. Percutaneous revascularization techniques with balloon angioplasty and stenting can be used to successfully treat occlusive disease of the vertebral and intracranial arteries. Percutaneous revascularization of intracranial and vertebral vessels with angioplasty and stenting is an effective strategy. The outcomes in this difficult to manage cohort of patients appears to be markedly improved over the natural history of this disease with medical therapy alone.

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Cerebral ischemia is due to either embolic or cerebrovascular occlusive disease, which most commonly occurs as a manifestation of atherosclerosis but can also result from fibromuscular dysplasia. Extracranial carotid artery bifurcation disease is the typical culprit in patients who present with transient ischemic attacks (TIAs) or strokes that occur in the temporal and frontal lobes. TIAs or strokes that occur in the posterior cerebrum and cerebellum are usually due to vertebral basilar disease. Occlusive disease of the origin of both vertebral arteries is usually necessary to precipitate symptoms of vertebrobasilar insufficiency; however, other combinations of carotid, subclavian, and innominate stenoses can compromise the posterior circulation and limit vascular supply. Although initial treatment of both anterior and posterior circulation symptomatology with platelet inhibitors and anticoagulants is warranted, arch and four-vessel study is indicated if symptoms continue despite medical management (1).

Although carotid endarterectomy has been proven more effective than medical therapy in the treatment of cervical carotid disease (2-4), there are no effective surgical strategies for the management of vertebral artery or intracranial carotid disease. Percutaneous revascularization of intracranial and vertebral arteries has no established indications or standard techniques, and no single specialty holds the clinical skill, knowledge, and technical ability to optimally perform these procedures. Management of patients with these conditions is well suited to a multidisciplinary team with the combined skills to provide optimal care. Neurologists screen patients for appropriate indications and independently assess outcomes. Interventional neuroradiologists or neurosurgeons have extensive knowledge and experience with intracranial vascular anatomy. An interventional cardiologist with peripheral vascular experience provides the team with extensive small vessel angioplasty and stenting techniques.

VERTEBRAL ANGIOPLASTY

The first reported successful treatment of the vertebrobasilar system by intraoperative percutaneous transluminal angioplasty (PTA) was by Sundt et al in 1980 (5). Since this initial report, multiple case reports and clinical series have described the successful use of PTA to treat posterior circulation atherosclerotic disease (6-10). Case reports describing percutaneous stent placement for the treatment of vertebral artery atherosclerotic occlusive disease have also been published (11-13). Malek et al reported a series of 21 patients with posterior circulation ischemia treated with balloon angioplasty and stent placement including 8 subclavian arteries and 13 vertebral arteries (14). Jenkins et al reported the largest series of vertebral artery stents to date, demonstrating the safety and efficacy of percutaneous primary vertebral artery stenting for the treatment of

Table 1. Overview of vertebral artery stenting studies.

Author (reference)	n	Procedural Complications	Mean Follow-up	Late stroke or TIA
Jenkins et al (15)	32	1 TIA	10.6 mo	1/32
Malek et al (14)	13	1 TIA	20.7 mo	N/A
Mukherjee et al (18)	12	None	6.4 mo	1/12

posterior circulation ischemia of 38 vertebral arteries in 32 patients (Table 1) (15).

Vertebral artery endarterectomy, vein patch angioplasty, and transection of the vertebral artery above the stenosis and subsequent reimplantation into the ipsilateral subclavian or carotid artery are the three commonly used surgical techniques for vertebral artery reconstruction (13). Surgical revascularization is not without significant morbidity and mortality. Complications include recurrent laryngeal nerve palsy, Horner's syndrome, lymphocele, chylothorax, and thrombosis (16).

Over the last 20 years, PTA of the supra-aortic vessels has progressed from an experimental technique to an accepted treatment with equal or superior results compared with surgical treatment in aortic arch and brachiocephalic vessels. Vertebral disease has been less well studied due to the infrequency of true posterior circulation symptomatology and the lack of a safe and effective revascularization technique. Our experience at Ochsner Clinic Foundation has included the percutaneous management of 38 vertebral arteries in 32 patients. Procedural success without periprocedural stroke or death was attained in all patients. At a mean follow-up of 10.6 months, 31 of 32 patients remained asymptomatic and one patient had recurrent symptoms from restenosis that was successfully dilated (15).

Our results and those of other investigators demonstrate vertebral artery stenting is a viable treatment option for patients with posterior circulation ischemia (14,15,17). Endoluminal stenting of vertebral artery lesions is safe and effective with a durable result as evidenced by the low recurrence rate. We believe that primary stent placement is an attractive treatment option for atherosclerotic vertebral artery disease (Figures 1-3).

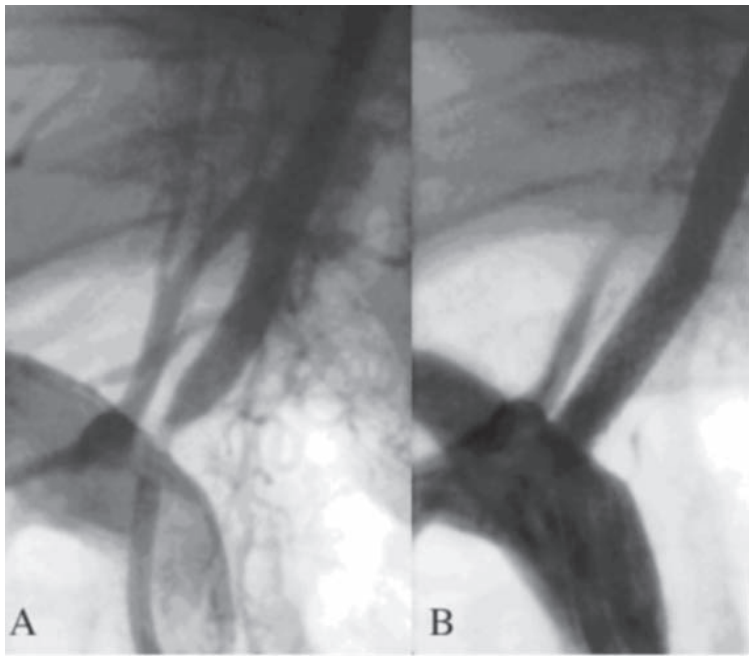

Figure 1. A. Left vertebral artery angiogram demonstrating a critical ostial stenosis. **B.** After balloon angioplasty and stent placement with standard coronary angioplasty equipment there is no residual stenosis.

INTRACRANIAL ANGIOPLASTY

Intracranial stenosis is associated with a poor prognosis with stroke rates of 27%-43% at 2-4 year follow-up among symptomatic patients (18,19). Asymptomatic patients with intracranial stenosis also have an excessive stroke risk of 23% at 7 years (20). No effective medical or surgical strategies have been demonstrated in the management of these patients. The Warfarin-Aspirin Symptomatic Intracranial

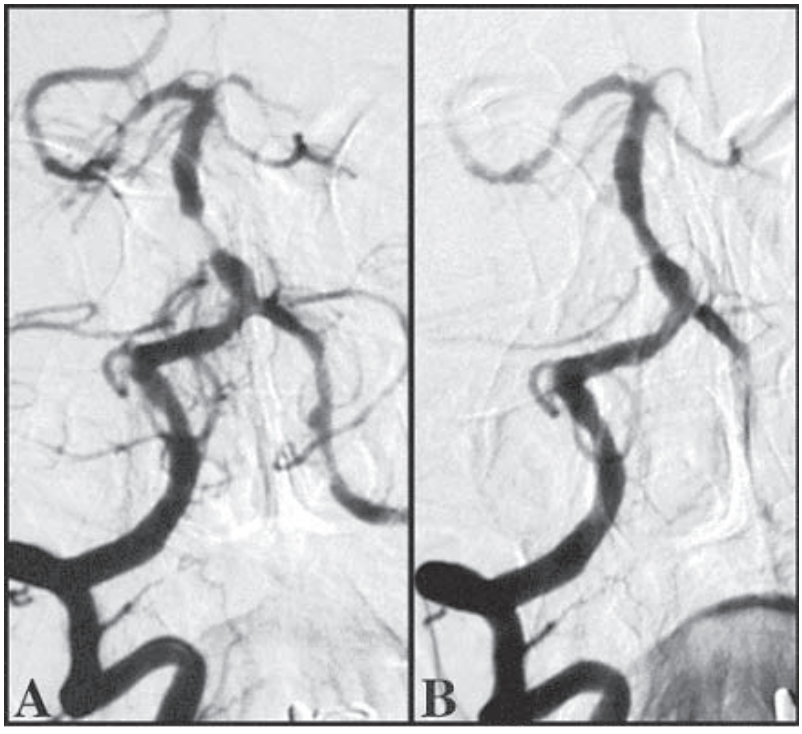

Figure 2. A. Midbasilar artery demonstrating a high-grade stenosis. **B.** Resolution of stenosis following percutaneous transluminal angioplasty alone.

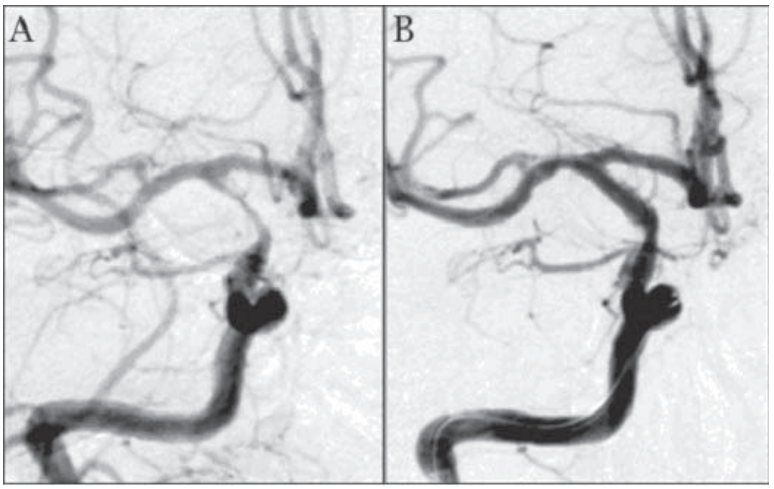

Figure 3. A. High-grade stenosis of the right intracranial internal carotid artery with occlusion of the contralateral carotid artery. **B.** Resolution of the stenosis following angioplasty.

Table 2. Overview of intracranial stenting studies.

Study (reference)	Patients	Technical Success	Periprocedure Stroke and Death (%)	Death (%)
Primary Stenting				
Gomez et al (29)	12	100%	0	0
Mori et al (28)	10	83%	0	0
Ramussen et al (30)	8	100%	25%	12.5%
Provisional Stenting				
Ramee et al (31,32)	31	100%	0	0

Disease (WASID) Study and the Extracranial/Intracranial (EC/IC) Bypass Study demonstrated that symptomatic patients with intracranial stenosis managed with medical therapy have a 7%-11% annual risk of stroke (21,22). Unlike cervical carotid stenosis, where carotid endarterectomy is more effective than medical therapy, the strategy of EC/IC bypass surgery has been has not been proven effective (22).

Balloon angioplasty and, more recently, stenting for intracranial stenosis has been performed in a few centers (23-26). The initial results of balloon angioplasty alone were not ideal with technical success of 68%-76% and a high rate of periprocedural stroke and death at 5%-33%. The principal cause for suboptimal balloon angioplasty was technical failure from dissection or elastic recoil. Percutaneous therapy in other vascular beds has demonstrated improved results with stenting compared with balloon angioplasty alone due to efficacy in treating dissections and elastic recoil. Several recent series of stenting for intracranial stenosis have shown a significant improvement compared with previous reports of balloon angioplasty, with technical success rates of 83%-100% and periprocedural stroke and death rates of 0%-12.5% (27-30) (Table 2).

At Ochsner, we employ a strategy of provisional stenting for suboptimal balloon angioplasty. Using this strategy, we have performed percutaneous revascularization of 31 patients with symptomatic intracranial stenosis, including 11 patients with basilar artery stenosis. We achieved technical success in 100% of patients with no periprocedural stroke or TIA. At last follow-up (mean of 10.4 months), two patients had a recurrent nondisabling stroke and two patients died of cardiac causes (31,32).

CONCLUSION

Percutaneous revascularization of intracranial and vertebral vessels with angioplasty and stenting is an effective strategy. The outcomes in this difficult to manage cohort of patients appear to be markedly improved over the natural history of this disease with medical therapy alone. The approach taken at our institution using a multidisciplinary team approach assures appropriate patient selection and management.

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