AJNR

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AJNR Am J Neuroradiol 2001, 22 (8 suppl) S31-S33
http://www.ajnr.org/content/22/8_suppl/S31

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Atherosclerotic disease affects the great vessels of the neck and head and can be the cause of profound neurologic insult. Surgical repair of lesions at the origin of these vessels is not as simple as that for cervical carotid bifurcation stenosis, and therefore, indications for endovascular therapy must be more flexible. Specifically, surgical repair of the aortic branches is difficult, but their repair is straightforward from an endovascular approach. The stenoses are typically neither as friable as carotid bifurcation lesions nor as often a source of emboli, but these data are not determined accurately. These stenoses can be dilated with or without stent placement with a high rate of success and durability and with low morbidity (1–9). Because of the difficult surgical approach and the relative safety and efficacy of endovascular reconstruction, angioplasty and stenting have largely replaced the direct surgical approach for repair of these lesions.

Indicator	Acceptable Threshold of Performance (%)
Ability to successfully access vessels	>95
Ability to deploy the stent	>95
Successful completion of procedure without neurologic sequelae	>95
Mortality	<2

Angioplasty and Stenting for Intracranial Atherosclerotic Disease

Intracranial atherosclerotic disease accounts for a significant portion of all ischemic strokes. The authors who presented the Warfarin-Aspirin Symptomatic Intracranial Disease Study (10) stated that 5% to 10% of all ischemic strokes are directly attributable to intracranial atherosclerotic lesions, thus accounting for approximately 50,000 to 70,000 strokes per year. African-American and Asian persons may have more intracranial vascular stenoses than extracranial carotid stenoses (11–14).

Previous studies have indicated a stroke risk of 8% per year to >20% per year with aspirin therapy for various intracranial stenoses of >50% severity, with or without previous symptoms. Warfarin therapy may lower this risk to <10% per year (10), but a recent report indicates that even warfarin therapy may be associated with an extremely high failure rate (15). Furthermore, another trial found that the medium term risk of stroke from an asymptomatic lesion (36% stroke, 45% death) was similar to the risk of stroke from a symptomatic lesion (45% stroke, 42% death), possibly because the insult from these lesions may not be embolic in nature but rather due to hemodynamic insufficiency (16). No trial of patients with extracranial stenoses has systematically evaluated the risk of stroke when treated with warfarin or found such a high risk of stroke as that found in the studies of intracranial stenoses. In addition, no trial has evaluated the true risk of a severe (>70%) intracranial stenosis, which would be expected to have a higher risk than the 50% diameter stenosis lesions previously studied.

For comparison, intracranial atherosclerotic disease is associated with a far higher risk of stroke and/or death than an unruptured aneurysm or an unruptured AVM. Intracranial atherosclerotic stenosis presents a higher risk for stroke than does a dural AVF, spinal AVM, or vertebral AVF. Available evidence suggests that even asymptomatic intracranial atherosclerotic stenosis is associated with a far higher risk for stroke than is asymptomatic extracranial carotid stenosis and that symptomatic intracranial stenosis probably has a higher cumulative risk than does symptomatic extracranial stenosis. Therefore, severe intracranial stenosis is one of the most intrinsically high risk vascular conditions encountered by neurointerventional surgeons. Although medical therapy probably decreases the risk of subsequent stroke from intracranial stenosis, it has been shown to have a disappointingly high failure rate (15–17). An additional trial is now underway to further evaluate the risk of stroke when patients are treated by medical means only.

Therapy for intracranial stenosis has been attempted by surgical as well as medical means. The Extracranial-Intracranial Bypass Study showed that vascular bypass procedures did not provide clinical benefit, with the worst results occurring in the group expected to do the best (those with stenosis of the MCA) (17).

Because of the high intrinsic risk of intracranial atherosclerotic stenosis, efforts to find and/or perfect a treatment for this condition should continue. Although new pharmaceutical agents are being developed, there currently is no available medication that effectively lowers the risk of stroke to an acceptable level (10, 15). Intracranial angioplasty and/or stenting offers the chance to maintain or re-

store normal hemodynamics and decrease the risk of stroke (18–41). New catheters, balloons, and stents allow the procedure to be performed with greater safety and success than was previously possible. Recent reported results indicate that this procedure is now relatively safe (35, 38, 40, 41).

The ASITN, therefore, maintains that intracranial angioplasty is appropriate for certain selected patients and can be performed with acceptable success rates and with beneficial results. Note, however, that no disease should be treated if the therapy presents a higher risk than the condition. For this reason, intracranial angioplasty for atherosclerotic stenosis should be performed only by a qualified neurointerventional surgeon on appropriately selected patients.

Success Rates for Intracranial Angioplasty

The ASITN encourages efforts to further study this disease process and its effective therapy. The ASITN maintains that it is premature to establish definitive success rates and threshold values for this procedure, particularly because the term *intracranial stenosis* encompasses lesions in different locations and with varying anatomy and that risk: benefit ratios are dependent on severity of stenosis, location, symptoms, and other factors. As additional data become available, the Society will endeavor to establish guidelines for technical success rates, complication rates, and threshold criteria. Success rates for emergent intracranial angioplasty associated with neurovascular rescue are particularly dependent on the preexisting cerebrovascular and parenchymal statuses and cannot be specified.

References

1. Vitek JJ. **Subclavian artery angioplasty at the origin of the vertebral artery.** *Radiology* 1989;170:407–409
2. Storey GS, Marks MP, Dake M, Norbash AM, Steinberg GK. **Vertebral artery stenting following percutaneous transluminal angioplasty: technical note.** *J Neurosurg* 1996;84:883–887
3. Imparato AM, Riles TS, Kim GE. **Cervical vertebral angioplasty for brain stem ischemia.** *Surgery* 1981;90:842–852
4. Courtheoux F, Tournade A, Theron J, et al. **Transcutaneous angioplasty of vertebral artery atheromatous ostial stricture.** *Neuroradiology* 1985;27:259–264
5. Bruckmann H, Ringlestein EB, Buchner H, Zeumer H. **Percutaneous transluminal angioplasty of the vertebral artery: a therapeutic alternative to operative reconstruction of proximal vertebral artery stenoses.** *J Neurol* 1986;233:336–339
6. Kachel R, Endert G, Basche S, Grossmann K, Glaser FH. **Percutaneous transluminal angioplasty (dilatation) of carotid, vertebral, and innominate artery stenoses.** *Cardiovasc Intervent Radiol* 1987;10:142–146
7. Kachel R. **Percutaneous transluminal angioplasty (PTA) of supra-aortic arteries especially of the carotid and vertebral artery: an alternative to vascular surgery?** *J Mal Vasc* 1993;18:254–257
8. Chastain HD, Campbell MS, Iyer S, et al. **Extracranial vertebral artery stent placement: in-hospital and follow-up results.** *J Neurosurg* 1999;91:547–552
9. Piotin M, Spelle L, Martin JB, et al. **Percutaneous transluminal angioplasty and stenting of the proximal vertebral artery for symptomatic stenosis.** *AJNR Am J Neuroradiol* 2000;21:727–731
10. Chimowitz MI, Kokkinos J, Strong J, et al. **The Warfarin-Aspirin Symptomatic Intracranial Disease Study.** *Neurology* 1995;45:1488–1493
11. Gorelick PB, Caplan LR, Hier DB, Parker SL, Patel D. **Racial differences in the distribution of anterior circulation occlusive disease.** *Neurology* 1984;34:54–59
12. Heyden S, Heyman A, Goree JA. **Nonembolic occlusion of the middle cerebral and carotid arteries: a comparison of predisposing factors.** *Stroke* 1970;1:363–369
13. Gorelick PB, Caplan LR, Hier DB, et al. **Racial differences in the distribution of posterior circulation occlusive disease.** *Stroke* 1985;16:785–790
14. Feldmann E, Daneault N, Kwan E, et al. **Chinese-White differences in the distribution of occlusive cerebrovascular disease.** *Neurology* 1990;40:1541–1545
15. Thijs VN, Albers GW. **Symptomatic intracranial atherosclerosis: outcome of patients who fail antithrombotic therapy.** *Neurology* 2000;55:490–497
16. Craig DR, Meguro K, Watridge C, Robertson JT, Barnett HJ, Fox AJ. **Intracranial internal carotid artery stenosis.** *Stroke* 1982;13:825–828
17. EC/IC Bypass Study Group. **Failure of extra-intracranial arterial bypass to reduce the risk of ischemic stroke: results of an international randomized trial.** *N Engl J Med* 1985;313:1191–1200
18. McKenzie JD, Wallace RC, Dean BL, Flom RA, Khayata MH. **Preliminary results of intracranial angioplasty for vascular stenosis caused by atherosclerosis and vasculitis.** *AJNR Am J Neuroradiol* 1996;17:263–268
19. Clark WM, Barnwell SL, Nesbit G, O'Neill OR, Wynn ML, Coull BM. **Safety and efficacy of percutaneous transluminal angioplasty for intracranial atherosclerotic stenosis.** *Stroke* 1995;26:1200–1204
20. Ahuja A, Guterman LR, Hopkins LN. **Angioplasty for basilar artery atherosclerosis: case report.** *J Neurosurg* 1992;77:941–944
21. Higashida RT, Hieshima GB, Tsai FY, Halbach VV, Norman D, Newton TH. **Transluminal angioplasty of the vertebral and basilar artery.** *AJNR Am J Neuroradiol* 1987;8:745–749
22. Sundt TM Jr, Smith HC, Campbell JK, Vliestra RE, Cucchiara RF, Stanson AW. **Transluminal angioplasty for basilar artery stenosis.** *Mayo Clin Proc* 1980;55:673–680
23. Purdy PD, Devous MD Sr, Unwin DH, Giller CA, Batjer HH. **Angioplasty of an atherosclerotic middle cerebral artery associated with improvement in regional cerebral blood flow.** *AJNR Am J Neuroradiol* 1990;11:878–880
24. Higashida RT, Tsai FY, Halbach VV, Dowd CF, Hieshima GB. **Cerebral percutaneous transluminal angioplasty.** *Stroke* 1993;2:497–502
25. Feldman RL, Trigg L, Gaudier J, Galat J. **Use of coronary Palmaz-Schatz stent in the percutaneous treatment of an intracranial carotid artery stenosis.** *Cathet Cardiovasc Diagn* 1996;38:316–319
26. Feldman RL, Rubin JJ, Kuykendall RC. **Use of coronary Palmaz-Schatz stent in the percutaneous treatment of vertebral artery stenoses.** *Cathet Cardiovasc Diagn* 1996;38:312–315
27. Takis C, Kwan ES, Pessin MS, Jacobs DH, Caplan LR. **Intracranial angioplasty: experience and complications.** *AJNR Am J Neuroradiol* 1997;18:1661–1668
28. Mori T, Mori K, Fukuoka M, et al. **Percutaneous transluminal cerebral angioplasty: serial angiographic follow-up after successful dilatation.** *Neuroradiology* 1997;39:111–116
29. Al-Mubarak N, Gomez CR, Vitek JJ, Roubin GS. **Stenting of symptomatic stenosis of the intracranial internal carotid artery.** *AJNR Am J Neuroradiol* 1998;19:1949–1951
30. Mori T, Fukuoka M, Kazita K, Mori K. **Follow-up study after intracranial percutaneous transluminal cerebral balloon angioplasty.** *AJNR Am J Neuroradiol* 1998;19:1525–1533
31. Dorros G, Cohn JM, Palmer LE. **Stent deployment resolves a petrous carotid artery angioplasty dissection.** *AJNR Am J Neuroradiol* 1998;19:392–394
32. Mori T, Kazita K, Mori K. **Cerebral angioplasty and stenting for an intracranial vertebral atherosclerotic stenosis.** *AJNR Am J Neuroradiol* 1999;20:787–789
33. Phatouros CC, Higashida RT, Malek AM, et al. **Endovascular stenting of an acutely thrombosed basilar artery: technical case report and review of the literature.** *Neurosurgery* 1999;44:667–673
34. Marks MP, Marcellus M, Norbash AM, Steinberg GK, Tong D, Albers GW. **Outcome of angioplasty for atherosclerotic intracranial stenoses.** *Stroke* 1999;30:1065–1069

35. Connors JJ III, Wojak JC. **Percutaneous transluminal angioplasty for intracranial atherosclerotic lesions: evolution of technique and short-term results.** *J Neurosurg* 1999;91:415–423
36. Morris PP, Martin EM, Regan J, Braden G. **Intracranial deployment of coronary stents for symptomatic atherosclerotic disease.** *AJNR Am J Neuroradiol* 1999;20;1688–1694
37. Gahn G, Richter A, Bourquain H, Hallmeyer S, Reichmann H, von Kummer R. **Cerebrovascular reserve before and after vertebral artery angioplasty.** *AJNR Am J Neuroradiol* 1999;20:785–786
38. Rasmussen PA, Perl J II, Barr JD, et al. **Stent-assisted angioplasty of intracranial vertebrobasilar atherosclerosis: an initial experience.** *J Neurosurg* 2000;92:771–778
39. Gomez CR, Misra VK, Campbell MS, Soto RD. **Elective stenting of symptomatic middle cerebral artery stenosis.** *AJNR Am J Neuroradiol* 2000;21:971–973
40. Mori T, Kazita K, Chokyu K, Mima T, Mori K. **Short-term arteriographic and clinical outcome after cerebral angioplasty and stenting for intracranial vertebrobasilar and carotid atherosclerotic occlusive disease.** *AJNR Am J Neuroradiol* 2000;21:249–254
41. Nahser HC, Henkes H, Weber W, Berg-Dammer E, Yousry TA, Kuhne D. **Intracranial vertebrobasilar stenosis: angioplasty and follow-up.** *Am J Neuroradiol* 2000;21:1293–1301