The risk of cerebrovascular accident in patients with asymptomatic critical carotid artery stenosis who undergo open-heart surgery

Idris M. Ali, MD; Brian Cummings, MD; John Sullivan, MD; Stewart Francis, BSc, RVT

Objective: To investigate whether the presence of asymptomatic critical carotid stenosis (ASCCS) increases the risk of perioperative stroke during open-heart surgery, which carries a well-established risk of cerebrovascular accidents.

Design: A case series.

Setting: A university-affiliated hospital that is a major referral centre for cardiovascular surgery.

Patients: Forty-six patients with ASCCS who underwent open-heart surgery between January 1992 and January 1996. Of this group, 27 had bilateral and 19 had unilateral critical carotid artery stenosis.

Interventions: Various cardiac procedures were performed on the 46 patients: 33 underwent coronary bypass grafting, 12 had valve replacement and 1 had heart transplantation.

Main outcome measure: Neurologic deficit.

Results: None of the patients had any perioperative neurologic deficit up to the date of discharge.

Conclusions: Cardiac procedures, without prior carotid artery surgery, can be done in patients with ASCCS with no significant added risk of stroke. To achieve this, blood pressure should be kept stable intraoperatively, at slightly higher than normal pressure.

Objectif : Déterminer si la présence d'une sténose asymptomatique critique de la carotide (SACC) aggrave le risque d'accident cérébrovasculaire peropératoire au cours d'une intervention chirurgicale à cœur ouvert, qui comporte un risque bien établi d'accident cérébrovasculaire.

Conception : Série de cas.

Contexte : Hôpital universitaire qui est un important centre de référence pour des interventions de chirurgie cardiovasculaire.

Patients : Quarante-six patients ayant une SACC qui ont subi une intervention chirurgicale à cœur ouvert entre janvier 1992 et janvier 1996. Sur ce total, 27 présentaient une sténose critique bilatérale et 19, une sténose critique unilatérale de la carotide.

Interventions : On a procédé à diverses interventions de chirurgie cardiaque sur les 46 patients : 33 ont subi un pontage aortocoronarien, 12, un remplacement de valvule et un, une transplantation cardiaque.

Principale mesure de résultat : Déficit neurologique.

Résultats : Aucun des patients n'avait présenté de déficit neurologique peropératoire à la date de la libération.

Conclusions : Chez les patients qui présentent une SACC, on peut procéder à des interventions de chirurgie cardiaque, sans intervention chirurgicale antérieure de l'artère carotide, sans aggraver le risque d'accident cérébrovasculaire. À cette fin, il faut stabiliser la tension artérielle, pendant l'intervention, à un niveau légèrement plus élevé que la tension normale.

From the Queen Elizabeth II Health Sciences Centre, Halifax, NS

Presented at the 65th annual meeting of the Royal College of Physicians and Surgeons of Canada, Halifax, NS, Sept. 29, 1996

Accepted for publication July 15, 1997

Correspondence to: *Dr. Idris M. Ali, New Halifax Infirmary Site, Ste. 2265, QEII Health Sciences Centre, 1796 Summer St., Halifax NS B3H 3A7; fax 902 473-4448*

Open-heart surgery carries a well-established risk of cerebrovascular accident. However, it is controversial whether patients with asymptomatic critical carotid stenosis (ASCCS) are at even higher risk than others, and whether surgical treatment of ASCCS should be carried out first, as has been advocated by a number of authors.[1–8] Others, however, feel that there is no added risk and have advocated ignoring asymptomatic carotid stenosis.[3,9–11] Our centre has adopted the latter opinion; consequently, carotid endarterectomy is performed only on symptomatic patients. To re-evaluate this issue, we reviewed the courses of patients who had ASCCS and who underwent open-heart surgery without carotid endarterectomy between January 1992 and January 1996. By comparing our results with those of other studies documented in the literature, we hoped to determine whether ASCCS increases the risk of perioperative cerebrovascular accidents in patients who undergo open-heart surgery.

Patients and methods

The study population comprised 46 patients (18 women, 28 men) with ASCCS who had various open-heart procedures alone, without carotid artery surgery, between 1992 and 1996. After thorough history-taking and physical examination, those patients admitted to our institution for elective open-heart procedures who demonstrated carotid bruits (unilateral or bilateral) were referred for Doppler scanning to evaluate the extent of their carotid artery disease. Those who had critical stenosis of more than 60% and were totally asymptomatic (i.e., no history of stroke or transient ischemic attacks [TIAs]) were included in the study. The age distribution is shown in Table I. Twenty-seven patients had bilateral and 19 had unilateral critical carotid artery stenosis greater than 60% (Table II). Coronary artery bypass grafting (CABG) was performed on 33 patients, valve replacement on 12 patients and heart transplantation on 1 patient (Table III). Of the entire group, 33 patients had a history of hypertension and 6 patients suffered from chronic atrial fibrillation. Cardiopulmonary bypass (pump) time ranged from 24 to 197 minutes (mean 98 minutes). Preoperatively, 34 patients were treated with acetylsalicylic acid and 5 were treated with coumadin; the remaining 7 were not taking any form of anticoagulation or antiplatelet therapy.

Direct carotid Doppler spectral analysis was performed by the same experienced registered vascular technologist using a 5-mH continuous wave probe. Carotid Doppler signals were analysed with a real-time sound spectral analyser. Techniques and diagnostic criteria described by Barnes and Rittgers[12,13] were used. Also, the techniques and criteria discussed by Moore and Bean[14] were used for indirect testing by periorbital Doppler, utilizing a 10 mH bidirectional probe. The Doppler scanning techniques used by our institution for over a decade have been found to provide a simple, rapid and accurate method of assessing hemodynamically significant stenosis. In our study, 60% stenosis (i.e., a greater than 60% reduction in the diameter of the internal carotid artery) was considered a critically significant lesion (this is the definition that was used by the Asymptomatic Carotid Atherosclerosis Study of 1994[15]). The carotid Doppler ultrasonography was done by the same technician, and its accuracy in detecting hemodynamically significant lesions was tested blindly and adequately by comparing the results with angiography and duplex ultrasonography.

For the 46 patients in the study,

Table I

Age Ranges of 46 Patients With Asymptomatic Critical Carotid Artery Stenosis (ASCCS) Who Underwent Open-Heart Procedures

Age range, yr	No. (and %) of patients
< 60	1 (2)
61–65	10 (22)
66–70	7 (15)
71–75	13 (28)
76–80	12 (26)
> 80	3 (7)
Total	46 (100)

Table II

Degree and Distribution of Carotid Stenosis

Degree of stenosis, %	Side, no. of lesions		Distribution, no. of patients	
	Right	Left	Unilateral	Bilateral
60–64	3	2	1	2
65–69	7	12	5	7
70–74	5	8	3	5
75–79	4	2	2	2
80–84	5	5	0	5
85–89	2	6	4	2
90–94	4	6	2	4
95–100	0	2	2	0
Total	30	43	19	27

stringent guidelines of care were followed in the operating room. Precautions were taken by both the anesthesiologist and perfusionist to maintain stable blood pressure throughout the procedure and, specifically, to keep the mean blood pressure between 60 and 70 mm Hg while each patient was on cardiopulmonary bypass. Postoperatively, the systolic blood pressure was kept slightly higher than usual. For example, a systolic pressure of 140 mm Hg is acceptable, especially in patients who have preoperative hypertension. In addition, the anesthesiologist took every precaution to avoid potential trauma to the carotid arteries by inserting pulmonary artery catheters and the invasive monitoring devices on the unaffected side of those patients with unilateral lesions, and by opting for a subclavian rather than jugular approach to invasive monitoring in those with bilateral lesions. Each patient's neurologic status was evaluated preoperatively and immediately postoperatively, with regular neurologic examinations performed at least daily while the patient remained in hospital. This was done by the nursing staff and the surgeons caring for the patients. Because the study was designed to evaluate specifically the effect of the actual surgical procedure on the stroke rate, the incidence of neurologic deficits was reported only for the immediate postoperative period (up to the discharge date) rather than for the standard 30 days.

Results

No patients suffered any neurologic deficits perioperatively for a period ranging from 6 to 15 days (mean 6.9 days). In addition, there were no reported deaths or significant morbidity in any of the patients enrolled in the study. Delayed discharge periods of more than 7 days were due to the need to adequately control the resistant postoperative atrial fibrillation in 7 patients and to monitor the coumadin dosage in 5 patients.

Table III

Open-Heart Procedures Performed

Procedure	Number (and %) of procedures
Coronary artery bypass grafting (CABG)	
1 vessel	2 (4)
2 vessels	9 (20)
3 vessels	17 (37)
4 vessels	5 (11)
Valve replacement and CABG	
Aortic valve	1 (2)
with 1-vessel CABG	1 (2)
with 2-vessel CABG	1 (2)
with 3-vessel CABG	1 (2)
Mitral valve	6 (13)
with 1-vessel CABG	1 (2)
Combined aortic and mitral values	1 (2)
Heart transplantation	1 (2)
Total	46 (100)

Discussion

There is general agreement in the literature that symptomatic critical carotid stenosis is associated with a 5-year stroke rate of 20% to 30%.[16–18] Other investigators contend that even asymptomatic lesions and stenosis of a lower degree (as low as 50%) increase the overall rate of TIA and the stroke rate.[6,19] We adopted the definition of critical stenosis used in the Asymptomatic Carotid Atherosclerosis Study (ACAS) of 1994, where it was defined as a 60% or more reduction in the diameter of the internal carotid artery.[15]

There is little controversy regarding the treatment of symptomatic critical carotid stenosis. Numerous studies have indicated an increased incidence of strokes if such a lesion is not surgically corrected.[16,19] Like others, Hertzer and colleagues[1] concluded that such severe disease warrants surgical treatment (i.e., carotid endarterectomy in conjunction with CABG to achieve additional protection from perioperative strokes).

However, the management of patients with coexisting ASCCS and coronary artery disease continues to be controversial.[1] Some researchers believe that the presence of ASCCS in conjunction with coronary artery disease increases the incidence of cerebrovascular accidents.[1,6,7,8,20,21] The impact of coexisting carotid artery disease on the stroke rate after CABG has recently been documented in 2 large, prospective, follow-up studies.[1,6] The incidence of stroke in patients with carotid bruits, a history of previous stroke, TIAs, or documented severe carotid artery disease while undergoing CABG has been estimated in case-controlled studies[7,8] and comparative studies[9,16] to be approximately 6%. Other prospective studies have evaluated the risk of

stroke in patients who have undergone CABG in the presence of extracranial bruits or documented evidence of extracranial lesions. Overall, the stroke rate in this population was approximately 3% to 4% in patients with asymptomatic stenosis and about 20% to 30% in those with symptomatic lesions.[9,11,20,22,23]

In addition, patients with documented carotid artery stenosis that was not surgically corrected showed a 4% stroke rate per year during the first 4 years after isolated CABG.[21] A recent follow-up study by Brener and colleagues[6] showed that the presence of carotid artery stenosis of 50% or greater in patients who undergo CABG increased the overall rate of TIAs and strokes from 1.9% to 9.2%. In light of the above-noted findings, many researchers have suggested that ASCCS be treated when it coexists with coronary artery disease. In 1994, the ACAS[15] concluded that asymptomatic patients with hemodynamically significant carotid artery stenosis (a 60% reduction in diameter of the internal carotid artery) had fewer strokes when treated with a combination of carotid endarterectomy (CEA) and optimum medical management (i.e., 325 mg acetylsalicylic acid and risk-factor reduction) than those treated with optimum medical management alone. In patients scheduled for CABG known to have bilateral hemodynamically significant lesions, many authors advocate treatment of at least 1 carotid artery as a staged procedure before coronary revascularization.[1,3,4] Vermeulen and colleagues[5] have suggested that in patients with severe cardiac disease, simultaneous CEA and CABG should be considered if both hemispheres are prone to stroke.

On the other hand, some authors have advocated a more conservative, nonoperative approach to asymptomatic carotid artery stenosis.[3,9,10,11] This approach is based on the fact that although asymptomatic carotid stenosis may be identified in approximately 10% of all candidates for myocardial revascularization, the perioperative stroke rate in this particular group has been reported not to exceed the usual figure (less than 3%) expected for CABG procedures.[9,10,21,22,24] Furthermore, published reports suggesting an increased perioperative stroke rate, as mentioned previously, may be fraught with confounding variables. Gardner and associates[7] have demonstrated the additional influence of factors such as increasing age and cardiopulmonary bypass time. Similarly, others have found that early death and stroke rates associated with CABG are directly related to age.[7,25–27] Vermeulen and colleagues[5] revealed, in their analysis of risk factors for all operative neurologic complications, that the preoperative occurrence of severe neurologic accidents, with or without residual deficits, and preoperative severe left ventricular dysfunction were significantly associated with postoperative neurologic events. Loop and associates[25] reported that postoperative strokes occurred after CABG in 137 (2.7%) of 5070 patients 65 years of age or older, and Gardner and associates[7] indicated that the risk of early stroke escalated to 6.3% among those over 70 years of age. Advanced age may contribute to higher stroke rates postoperatively because of the higher risks of atheromatous embolization during manipulation of the ascending thoracic aorta and less tolerance for cardiopulmonary bypass because of intracranial arterial disease.

The wide variations in the composition of the published series of patients with coexisting severe carotid and coronary artery disease make it difficult to reach concordant conclusions. For example, factors such as the percentage of patients with previous strokes or TIAs and the number of patients with severe bilateral or unilateral disease vary from one study to another.[5] In addition, from a practical standpoint, the relatively low prevalence of serious carotid artery disease in patients scheduled for CABG precludes the evaluation of large study populations.[1,5] Many factors contribute to the difficulty in drawing conclusions about patients with coexisting severe carotid and coronary artery disease. In our study, the 46 patients with preoperative documented evidence of ASCCS were taken from a pool of 4107 patients who underwent various cardiac procedures between 1992 and 1996. The general incidence of postoperative stroke in this pool of patients was 1.7%. The selected 46 patients underwent various open-heart operations involving careful intraoperative precautions and experienced no evidence of any perioperative neurologic deficits before discharge from hospital. Such significant results could stem from the operative precautions that were taken (i.e., maintaining a stable blood pressure and avoiding compression of the carotid arteries). Although the number of patients in this study is relatively small and a larger series may be required to establish more concrete conclusions, the age distribution, degree of stenosis, length of pump time and the type of surgical procedure represent most of the important variables in this controversial surgical problem. Overall, this study showed that cardiac surgery alone, without carotid endarterectomy, can be done in patients with ASCCS with no added risk of perioperative neurologic complications. In addition, we noted that preoperative anticoagulation or antiplatelet therapy, cardiopulmonary pump time and type of heart procedure were not significant variables.

References

1. Hertzer NR, Loop FD, Beven EG, O'Hara PJ, Krajewski LP. Surgical staging for simultaneous coronary and carotid disease: a study including prospective randomization. *J Vasc Surg* 1989;9(3):455-63.
2. Moore WS, Young B, Baker WH, Robertson JT, Toole JF, Vescera CL, et al. Surgical results: a justification of the surgeon selection process for the ACAS trial. *J Vasc Surg* 1996;23(2): 323-8.
3. Ivey TD. Combined carotid and coronary disease — a conservative strategy. *J Vasc Surg* 1986;3:687-9.
4. Hertzer NR, Loop FD, Taylor PC, Beven EG. Combined myocardial revascularization and carotid endarterectomy. Operative and late results in 331 patients. *J Thorac Cardiovasc Surg* 1983;85(4):577-89.
5. Vermeulen EE, Hamerlijnk RP, Defauw JJ, Ernst SM. Synchronous operation for ischemic cardiac and cerebrovascular disease: early results and long-term follow-up. *Ann Thorac Surg* 1992;53:381-90.
6. Brener BJ, Brief DK, Alpert J, Goldenkranz RJ, Parsonnet V. The risk of stroke in patients with asymptomatic carotid stenosis undergoing cardiac surgery — a follow-up study. *J Vasc Surg* 1987;5(2):269-79.
7. Gardner TJ, Horneffer PJ, Manolio TA, Hoff SJ, Pearson TA. Major stroke after coronary artery bypass surgery: changing magnitude of the problem. *J Vasc Surg* 1986;3(4):684-7.
8. Read GL, Singer DE, Picard EH, DeSanctis RW. Stroke following coronary artery bypass surgery: a case-control estimate of the risk of carotid bruits. *N Engl J Med* 1988;319:1246-50.
9. Breslau PJ, Fell G, Ivey TD, Bailey WW, Miller DW, Strandness ED Jr. Carotid arterial disease in patients undergoing coronary artery bypass operations. *J Thorac Cardiovasc Surg* 1981;82(5):765-7.
10. Turnipseed WD, Berkoff HS, Belzer FO. Postoperative stroke in cardiac and peripheral vascular disease. *Ann Surg* 1980;192:365-8.
11. Barnes RW, Marszalek PB. Asymptomatic carotid disease the cardiovascular surgical patient: Is prophylactic endarterectomy necessary? *Stroke* 1981; 12(4):497-500.
12. Rittgers SE, Putney WW, Barnes RW. Early detection of stroke-related lesions by real-time Doppler spectral analysis. In: Hershey FB, Barnes RW, Sumner DS, editors. *Noninvasive diagnosis of vascular disease*. Pasadena (CA): Appleton Davies; 1984. p. 248-57.
13. Barnes RW. The role of ultrasound in the diagnosis of carotid artery disease. In: Baker WM, editor. *Diagnosis and treatment of carotid artery disease*. 2nd rev. ed. Mount Kisco (NY): Futura Publishing; 1985. p. 29-55.
14. Moore WS, Bean BA. Periorbital Doppler examination (ophthalmosonographic and supraorbital photoplethysmography). In: Kempczinski RF, Yao JST, editors. *Practical noninvasive vascular diagnosis*. Chicago: Year Book Medical Publishers; 1982. p. 145-66.
15. Clinical advisory: carotid endarterectomy for patients with asymptomatic internal carotid artery stenosis. *Stroke* 1994;25(12):2523-4.
16. Moneta GL, Taylor DC, Nicholls SC, Bergelin RO, Zierler RE, Kazmers A, et al. Operative versus nonoperative management of asymptomatic high-grade internal carotid artery stenosis: improved results with endarterectomy. *Stroke* 1987;18(6):1005-10.
17. Hertzer NR, Flanagan RA Jr, Beven EG, O'Hara PJ. Surgical versus nonoperative treatment of symptomatic carotid stenosis. 211 patients documented by intravenous angiography. *Ann Surg* 1986;204(2):154-62.
18. Hertzer NR, Flanagan RA Jr, Beven EG, O'Hara PJ. Surgical versus nonoperative treatment of symptomatic carotid stenosis. 290 patients documented by intravenous angiography. *Ann Surg* 1986;204(2):163-71.
19. Moore DJ, Miles RD, Gooley NA, Sumner DS. Noninvasive assessment of stroke risk in asymptomatic and nonhemispheric patients with suspected carotid disease. Five-year follow-up of 294 unoperated and 81 operated patients. *Ann Surg* 1985;202(4):491-504.
20. Barnes RW. Asymptomatic carotid disease in patients undergoing major cardiovascular operations: Can prophylactic endarterctomy be justified? [review]. *Ann Thorac Surg* 1986;42(6 Suppl): S36-40.
21. Barnes RW, Nix ML, Sansonetti D, Turley DG, Goldman MR. Late outcome of untreated asymptomatic carotid disease following cardiovascular operations. *J Vasc Surg* 1985;2: 843-9.
22. Barnes RW, Liebman PR, Marszalek PB, Kirk CL, Goldman MH. The natural history of asymptomatic carotid disease in patients undergoing cardiovascular surgery. *Surgery* 1981;90: 1075-83.
23. Hornig CR, Lammers C, Stertmann WA, Scheld HH, Dorndorf W. Neurologische komplikationen koronarer Bypassoperationen — eine prospektive Untersuchung. *Fortschr Neurol Psychiatr* 1990;58(2):76-83.
24. Hart RG, Easton JD. Management of cervical bruits and carotid stenosis in perioperative patients. *Stroke* 1983;14: 290-7.
25. Loop FD, Lytle BW, Cosgrove DM, Goormastic M, Taylor PC, Golding LAR, et al. Coronary artery bypass graft surgery in the elderly. *Cleve Clin J Med* 1988;55:23-4.
26. Gersh BJ, Kronmal RA, Frye RL, Schaff HV, Ryan TJ, Gosselin AJ, et al. Coronary arteriography and coronary artery bypass surgery: morbidity and mortality in patients ages 65 years or older. A report from the Coronary Artery Surgery Study. *Circulation* 1983;67(3):483-91.
27. Gersh BJ, Kronmal RA, Schaff HV, Frye RL, Ryan TJ, Myers WO, et al. Long-term (5 year) results of coronary bypass surgery in patients 65 years old or older: a report from the Coronary Artery Surgery Study. *Circulation* 1983;68(Suppl II):II-190-9.