

# Stroke

American Stroke  
Association<sup>SM</sup>

A Division of American  
Heart Association



JOURNAL OF THE AMERICAN HEART ASSOCIATION

## **Improved prognosis for asymptomatic carotid stenosis with prophylactic carotid endarterectomy**

JA Freischlag, D Hanna and WS Moore

*Stroke* 1992;23:479-482

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 72514  
Copyright © 1992 American Heart Association. All rights reserved. Print ISSN: 0039-2499. Online ISSN:  
1524-4628

The online version of this article, along with updated information and services, is  
located on the World Wide Web at:

<http://stroke.ahajournals.org>

Subscriptions: Information about subscribing to Stroke is online at  
<http://stroke.ahajournals.org/subscriptions/>

Permissions: Permissions & Rights Desk, Lippincott Williams & Wilkins, a division of Wolters  
Kluwer Health, 351 West Camden Street, Baltimore, MD 21202-2436. Phone: 410-528-4050. Fax:  
410-528-8550. E-mail:  
[journalpermissions@lww.com](mailto:journalpermissions@lww.com)

Reprints: Information about reprints can be found online at  
<http://www.lww.com/reprints>

## Original Contributions

# Improved Prognosis for Asymptomatic Carotid Stenosis With Prophylactic Carotid Endarterectomy

Julie A. Freischlag, MD; Dinah Hanna, MD; and Wesley S. Moore, MD

**Background and Purpose:** The value of carotid endarterectomy in asymptomatic patients with high-grade stenosis is controversial. The objective of this study is to compare the immediate and long-term outcome of patients after carotid endarterectomy for asymptomatic carotid stenosis (>75%) with the reported natural history of patients followed nonoperatively to determine whether carotid endarterectomy reduces the subsequent neurological event rate.

**Methods:** The data from 141 carotid endarterectomies performed in 123 patients between January 1980 and December 1986 were reviewed from the perspective of perioperative results and long-term follow-up to January 1990, providing a follow-up ranging from 3 to 10 years. The mean follow-up was 56.6 months (range 27–117 months).

**Results:** There were no perioperative deaths. There were two postoperative strokes: one in the cerebellar distribution and one in the middle cerebral distribution. During the course of follow-up, no patient suffered a stroke in the hemisphere ipsilateral to carotid endarterectomy. One patient developed ipsilateral transient ischemic attacks 24 months after surgery associated with carotid restenosis. A total of three patients developed four recurrent carotid stenoses, for an incidence of 2.8%. All four recurrences were corrected surgically.

**Conclusions:** These findings are in marked contrast to the reported natural history of patients with >75% stenosis in which the 1-year neurological event rate is 18% and the 1-year stroke rate is 5%. Although final proof of efficacy for prophylactic carotid endarterectomy in asymptomatic patients will await the outcome of randomized trials, until these data are available, prophylactic carotid endarterectomy is justified in centers of excellence that can perform the surgery with low perioperative risk. (*Stroke* 1992;23:479–482)

**KEY WORDS** • carotid artery diseases • endarterectomy • prognosis

The role of carotid endarterectomy in asymptomatic patients with extracranial arterial occlusive disease remains controversial. Prophylactic carotid endarterectomy will be of benefit to the patient if it can prevent a future stroke and if the operation can be done with a morbidity and mortality sufficiently low as to be therapeutically competitive with the natural history of the disease. Those who argue against the efficacy of prophylactic carotid endarterectomy believe that the operative morbidity and mortality outweigh the benefits of successful endarterectomy. Furthermore, they question whether prophylactic operation will significantly lower the subsequent stroke risk. Finally, they have expressed concern that the longevity of patients with carotid artery disease is so abbreviated because of concomitant coronary artery disease that the patients will not live sufficiently long to enjoy the benefits of prophylaxis.<sup>1–3</sup> The objective of this study is to document the perioperative morbidity and mortality, the long-term results with respect to ipsilateral and contralateral neu-

rological events, and the longevity of a group of patients undergoing prophylactic carotid endarterectomy for high-grade stenosis at the UCLA Medical Center.

### Subjects and Methods

Between January 1980 and December 1986 141 carotid endarterectomies were performed in 123 patients (mean age, 67 years [range 42–83 years]; 72 men, 51 women) with the diagnosis of asymptomatic carotid stenosis at the UCLA Medical Center. Patients were defined as asymptomatic if they had not experienced amaurosis fugax, focal transient ischemic events, or cerebral infarction in the ipsilateral carotid distribution before operation. Indication for operation in the asymptomatic artery was limited to stenoses >75% as documented by angiography or duplex scanning. The criteria for 75% stenosis was the reduction in diameter by angiography or with internal carotid artery/common carotid artery peak velocity ratio >3.7 and diastolic velocity ratio >5.5 with pronounced turbulence detectable distal to the stenosis site. Contralateral carotid arteries were carefully assessed at the time of initial presentation, and staged bilateral carotid endarterectomies were performed in asymptomatic patients, when indicated. Patients with contralateral symptomatic carotid artery disease had the symptomatic artery oper-

From the Division of Vascular Surgery, UCLA Center for the Health Sciences, Los Angeles, Calif.

Address for reprints: Wesley S. Moore, MD, Department of Surgery, Section of Vascular Surgery, UCLA Medical Center, 10833 LeConte Avenue, Los Angeles, CA 90024-6094.

Received August 28, 1991; accepted December 3, 1991.

ated on first. Data concerning patient risk factors, presence of contralateral carotid disease symptoms, results of cerebral angiography, preoperative and postoperative duplex scanning, details of operations, perioperative complications, and immediate and long-term postoperative results were abstracted from the patient records. Follow-up data were obtained from current outpatient clinic records, telephone conversation with the patient, contact with the referring physician, and review of records from other hospitals or family members for those who died in the interval. Event rates and survival rates were expressed using the life table method and were compared with similar data and reports documenting the natural history of similar groups of patients with respect to neurological event rates.

**Results**

One hundred forty-one carotid endarterectomies were performed in 123 patients for the diagnosis of asymptomatic stenosis. Eighteen patients underwent staged bilateral carotid endarterectomy for bilateral asymptomatic carotid disease. Thirty-one percent of patients had findings of coronary artery disease as determined by a history of angina, myocardial infarction, or a prior coronary artery bypass grafting. Sixty-three percent of patients had a history of hypertension, 70% admitted to cigarette smoking, and 25% of the patients were diabetic. The minimum asymptomatic lesion accepted for prophylactic operation was a 75% stenosis as documented by angiography or duplex scanning. Twenty-six patients (21.2%) had had a prior contralateral carotid endarterectomy for symptomatic carotid disease.

There were no postoperative deaths. There were two postoperative strokes (one in the cerebellar distribution occurring 24 hours postoperatively and the other in the middle cerebral distribution immediately after operation), for a postoperative stroke rate of 1.4%. The patient with the cerebellar stroke had complete resolution of symptoms. The patient with the stroke in the middle cerebral distribution recovered with only minimal residual weakness in the hand. Minor perioperative complications included four episodes of transient cranial nerve dysfunction (two recurrent laryngeal and two hypoglossal), from which the patients recovered completely. One patient had a postoperative hematoma that required surgical drainage. One patient experienced ipsilateral transient ischemic attacks (TIAs) 1 week after operation and was found to have a carotid artery thrombosis, which was surgically repaired without incident. Two patients experienced postoperative myocardial infarctions without sequelae.

At the time of this review, follow-up information was complete in 118 patients (96%). Five patients were lost to follow-up at 27, 30, 40, 61, and 78 months after operation. Follow-up information was obtained on the balance of patients reviewed at the time of this report or until their death. All of these patients had been seen by their surgeon within 1 year of this report. Mean follow-up interval was 56.6 months, with a range of 27–117 months. During the course of follow-up, no patient experienced a stroke in the distribution of an operated carotid artery.

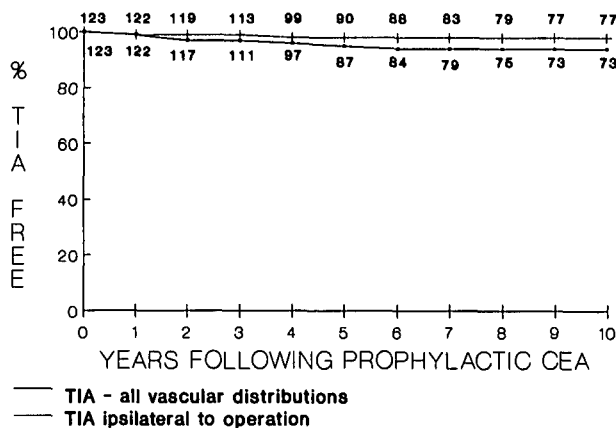


FIGURE 1. Life table analysis demonstrating 97%, 95%, and 94% transient ischemic attack (TIA)-free rates at 3, 5, and 10 years, respectively, after carotid endarterectomy (CEA). Ipsilateral TIA-free rates were 99% at 3 years and 98% at 5 and 10 years.

There were four recurrent carotid stenoses (2.8%) in three patients during the course of follow-up evaluation. One patient underwent reoperation at 11 months for an asymptomatic restenosis caused by myointimal hyperplasia. A second patient underwent reoperation at 24 months for a recurrent stenosis productive of hemispheric TIAs. A third patient underwent staged bilateral reoperation at 20 and 24 months for asymptomatic restenosis caused by myointimal hyperplasia.

A total of five patients experienced a stroke in a vascular distribution other than the operated carotid artery. Three of these patients experienced stroke in the opposite, nonoperated carotid distribution at 24, 47, and 57 months after ipsilateral prophylactic carotid endarterectomy with continued patency and no symptoms in the distribution of the operated side. One patient experienced a lacunar stroke in the opposite hemisphere 36 months after contralateral prophylactic carotid endarterectomy, and the fifth patient experienced a brain stem stroke 10 months after prophylactic carotid endarterectomy. Two of the patients who experienced stroke had antecedent TIAs: one in the carotid distribution and one in the posterior circulation distribution. An additional two patients began to experience TIAs in the nonoperated carotid artery distribution at 11 and 36 months after contralateral prophylactic carotid endarterectomy. These two patients and the patient with TIA and subsequent stroke underwent carotid endarterectomy on the symptomatic side.

During the course of follow-up, 39 patients (31.7%) died. No late death occurred from a stroke. Life table analysis revealed an ipsilateral TIA-free rate on the side of the operation of 99% at 3 years and 98% at 5 and 10 years (Figure 1). The stroke-free rate ipsilateral to carotid endarterectomy was 98% at 3, 5, and 10 years (Figure 2). The TIA-free rate in all vascular distributions was 97%, 95%, and 94% at 3, 5, and 10 years, respectively (Figure 1). Similarly, strokes in all distributions including the operated artery were examined, and the stroke-free rates were 97%, 94%, and 93% at 3, 5, and 10 years (Figure 2). When one combined the end points of stroke in any distribution and death, the stroke-free survival rates were 90%, 72%, and 62% at 3,

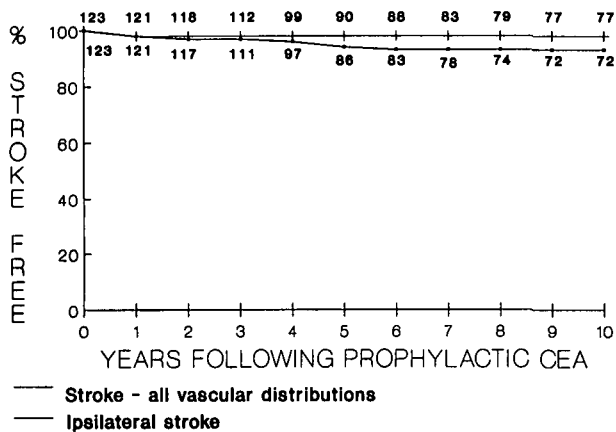


FIGURE 2. Life table analysis demonstrating 97%, 94%, and 93% stroke-free rates at 3, 5, and 10 years, respectively, after carotid endarterectomy (CEA) and an ipsilateral stroke-free rate of 98% at 3, 5, and 10 years.

5, and 10 years, respectively (Figure 3). Ipsilateral stroke-free survival rates were 90%, 75%, and 65% at 3, 5, and 10 years, respectively (Figure 3).

The overall survival rate, calculated by the life table method, was 92.4% at 3 years, 76% at 5 years, and 66.5% at 10 years (Figure 3). Thus, the average mortality rate was 3.4% per year in follow-up over the 10 years of the study.

**Discussion**

Prophylactic carotid endarterectomy has been a controversial topic, primarily because the natural history of asymptomatic carotid lesions had not been well defined and several published reports appeared to be at variance. Another reason for the controversy has been concern about the risk of the operation in communities versus in specialized centers. Finally, it has been questioned whether prophylactic operation would materially improve the outcome of that portion of the brain in patients operated on within the distribution of the operated artery.

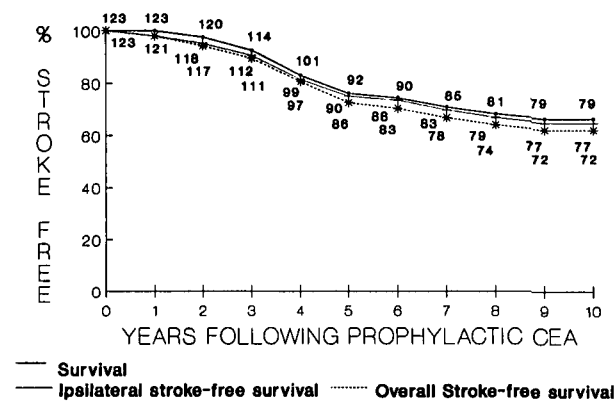


FIGURE 3. Life table analysis revealing stroke-free survival rates of 90%, 72%, and 62% at 3, 5, and 10 years, respectively, after carotid endarterectomy (CEA). Ipsilateral stroke-free survival rates were 90%, 75%, and 65% at 3, 5, and 10 years, respectively. Overall survival rate was 92.4% at 3 years, 76% at 5 years, and 66.5% at 10 years.

Early attempts at natural history definition included the Evans County, Georgia study, which followed a group of patients with asymptomatic carotid bruits and found their stroke risk to be approximately 2% per year.<sup>4</sup> A similar report from the Framingham study documented the same stroke incidence.<sup>5</sup> In the Framingham study, the presence of a carotid bruit correlated much better with fatal myocardial infarction than it did with subsequent stroke. Both of these studies were flawed because of the failure to define the underlying lesion in patients with carotid bruits since many patients with carotid bruit may have minimal lesions. In fact, the incidence of high-grade carotid stenosis in a patient population with carotid bruit is only about 20%.<sup>6-8</sup>

With the advent of noninvasive diagnostic techniques, the opportunity to carry out appropriate carotid artery screening without invasive angiography became available. Kartchner and McRae<sup>9</sup> were able to report an increased risk of stroke in those patients with positive noninvasive tests who subsequently underwent vascular or cardiac operations. Their perioperative stroke rate when the carotid lesion was uncorrected was 17% versus a 1% stroke incidence in a similar group of patients without critical carotid lesions.

Roederer and colleagues<sup>10</sup> reported their experience with a group of patients followed periodically with carotid duplex scanning. They noted that approximately one third of the patients with minimal lesions would progress to >50% stenoses within the 3 years of observation. Second, they noted that in 89% of their patients who developed symptoms (TIA or stroke), such symptoms were preceded by disease progression to >80% stenosis. Finally, they noted that a disease progression of a lesion to >80% stenosis carried a 35% risk of either symptoms or carotid artery occlusion within 6 months of the observed progression and a 46% risk of adverse event within 12 months of observation. The progression to an asymptomatic occlusion should not be considered a benign event because it has been shown that patients with a totally occluded internal carotid artery continue to be at risk for stroke at the rate of 5-10% per year, and because the cervical vessel is now totally occluded, a carotid endarterectomy is no longer possible.<sup>11,12</sup>

One of the most important contemporary studies of the natural history of carotid artery disease was reported by Chambers and Norris,<sup>1,2</sup> who followed 500 patients with noninvasive examination every 6 months. In observing neurological event rates, they identified two critical parameters: a stenosis >75% or evidence of disease progression between two study intervals. The 1-year event rate (TIA and stroke) for patients with stenoses >75% was 18%. The 1-year stroke rate in the same category of patient was 5%. It was of further interest that approximately one half of their patients were taking aspirin, and the incidence of neurological events was identical among patients taking aspirin and those who did not.

The immediate results and long-term benefit of carotid endarterectomy in patients with asymptomatic stenoses were reported by Moore and colleagues.<sup>13</sup> They reported 78 carotid endarterectomies in 72 asymptomatic patients with no postoperative deaths or strokes. These patients were then followed for an interval up to 10 years with an average annual stroke

rate of 0.3% per year. Similar results were reported by Bernstein et al,<sup>14</sup> with a late stroke rate of 3% in 87 patients after carotid endarterectomy followed for an average of 3.8 years. Healy and colleagues<sup>15</sup> reported a 0.65% per year stroke rate following carotid endarterectomy for asymptomatic stenosis.

In the present series, the perioperative mortality was 0%, and the perioperative stroke rate was 1.6%. Using life table analysis, followed for 10 years, the ipsilateral TIA rate was 2% at 10 years (0.2% per year), and the ipsilateral stroke rate was 2% at 10 years (0.2% per year). Looking at the worst-case scenario, which included neurological events in all distributions including the operated artery, the overall TIA rate was 6% at 10 years (0.6% per year), and the overall stroke rate was 7% at 10 years (0.7% per year). This rate is markedly lower than the 18% per year neurological event rate reported by Chambers and Norris and the 5% annual stroke rate in the same series.<sup>1,2</sup>

The concern that a high mortality rate from coronary disease would make it impossible for patients to enjoy the benefits of stroke risk prophylaxis is not borne out in this series in which survival was 92.4% at 3 years, 76% at 5 years, and 66.5% at 10 years. A 3.4% per year mortality rate is sufficiently low to indicate that in contemporary series patients are living longer and, therefore, live long enough to enjoy the benefits of stroke prophylaxis. Furthermore, a comparison of the survival curve with the stroke-free survival curve reveals them to be almost identical, indicating that those patients who survived also did so without suffering a stroke (Figure 3).

The strongest scientific proof of efficacy of a therapeutic modality is the prospective randomized trial. One such trial, sponsored by the Veterans Administration, has been completed, and results will be reported soon.<sup>16</sup> The second such trial is being sponsored by the National Institutes of Health.<sup>17</sup> It will be several years before data are available from this trial. In the absence of a prospective randomized trial, the next strongest evidence of efficacy is a comparison of the results and long-term outcome of the therapeutic modality with the natural history data of a group of patients so treated in a contemporary fashion. In a recent report, the Stroke Council of the American Heart Association has recommended that the combined operative morbidity and mortality for patients with asymptomatic carotid stenosis must be kept <3.0%.<sup>18</sup> In our present study, the combined rate was 1.6%. Legitimate concern has been expressed that the results from specialized centers may not be duplicated in community-wide analysis. The only solution to this problem involves the use of a continual audit of individual surgeons' results within their own hospital community. Therefore, it would seem logical that a surgeon would have to demonstrate that his individual complication rate did not exceed 3.0% in order to justify recommendations for prophylactic carotid endarterectomy. With that caveat, and while awaiting the results from the prospective randomized trials, the results of this study add further evidence to justify the practice of prophylactic carotid endarterec-

tomy in carefully selected patients with stenoses >75%, providing that the operation can be safely performed within the parameters suggested by the Stroke Council of the American Heart Association.

#### Note

See National Auxiliary Publications Service document 04934 for 18 pages of supplementary materials. Order from NAPS c/o Microfiche Publications, PO Box 3513, Grand Central Station, New York, NY 10163-3513. Remit in advance, in US funds only, \$7.75 for photocopies or \$4 for microfiche. Outside the United States or Canada, add postage of \$4.50 for the first 20 pages and \$1 for each 10 pages of material thereafter. The postage charge for a microfiche order is \$1.75 for the first microfiche and \$.50 for each additional microfiche.

#### References

1. Chambers BR, Norris JW: The case against surgery for asymptomatic carotid stenosis. *Stroke* 1984;15:964-967
2. Chambers BR, Norris JW: Outcome in patients with asymptomatic neck bruits. *N Engl J Med* 1986;315:860-865
3. Humphries AW, Young JR, Santilli PH, Beven EG, deWolfe VG: Unoperated, asymptomatic significant internal carotid artery stenosis: A review of 182 instances. *Surgery* 1976;80:695-698
4. Heyman A, Wilkinson WE, Heyden S, Helms MJ, Bartel AG, Karp HR, Tyroler HA, Hames CG: Risk of stroke in asymptomatic persons with cervical arterial bruits: A population study in Evans County, Georgia. *N Engl J Med* 1980;302:838-841
5. Wolf PA, Kannel WB, Sorlie P, McNamara P: Asymptomatic carotid bruit and risk of stroke: The Framingham study. *JAMA* 1981;245:1442-1445
6. Malone JM, Bean B, Laguna J, Hamilton R, Labadie E, Moore WS: Diagnosis of carotid artery stenosis: Comparison of oculo-plethysmography and Doppler supraorbital examination. *Ann Surg* 1980;191:347-353
7. Moore WS, Bean B, Burton R, Goldstone J: The use of ophthalmoscopy in the diagnosis of carotid artery stenosis. *Surgery* 1977;82:107-115
8. Ziegler DK, Zileli T, Dick A, Sebaugh JL: Correlation of bruits over the carotid artery with angiographically demonstrated lesions. *Neurology* 1971;21:860-865
9. Kartchner MM, McRae LA: Non-invasive evaluation and management of the asymptomatic carotid bruit. *Surgery* 1977;82:840-847
10. Roederer GO, Langlois YE, Jager KA, Primozich JF, Beach KW, Phillips DJ, Strandness DE Jr: The natural history of carotid artery disease in asymptomatic patients with cervical bruits. *Stroke* 1984;15:605-613
11. Cote R, Barnett HJM, Taylor DW: Internal carotid occlusion: A prospective study. *Stroke* 1983;14:898-902
12. Nicholls SC, Bergelin R, Strandness DE: Neurologic sequelae of unilateral carotid artery occlusion: Immediate and late. *J Vasc Surg* 1989;10:542-548
13. Moore WS, Boren C, Malone J, Goldstone J: Asymptomatic carotid stenosis: Immediate and long term results after carotid endarterectomy. *Am J Surg* 1979;138:228-233
14. Bernstein EF, Humber VJ, Collins GM, Dilley RB, Devin JB, Stuart SH: Life expectancy and late stroke following carotid endarterectomy. *Ann Surg* 1983;198:80-86
15. Healy DA, Clowes AW, Zierler RE, Nicholls SE, Bergelin RO, Primozich BS, Strandness DE Jr: Immediate and long term results of carotid endarterectomy. *Stroke* 1989;20:1138-1142
16. Veterans Administration Cooperative Study: Role of carotid endarterectomy in asymptomatic carotid stenosis. *Stroke* 1986;17:534-548
17. The Asymptomatic Carotid Atherosclerosis Study Group: Study design for randomized prospective trial of carotid endarterectomy for asymptomatic atherosclerosis. *Stroke* 1989;20:844-849
18. Beebe HG, Clagett GP, DeWeese JA, Moore WS, Robertson JT, Sandok B, Wolf PA: Assessing risk associated with carotid endarterectomy. *Stroke* 1989;20:314-315