

Stroke

JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Stroke
AssociationSM

A Division of American
Heart Association



Asymptomatic carotid disease in the cardiovascular surgical patient: is prophylactic endarterectomy necessary?

RW Barnes and PB Marszalek

Stroke 1981;12:497-500

Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 72514
Copyright © 1981 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

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

Asymptomatic Carotid Disease in the Cardiovascular Surgical Patient: Is Prophylactic Endarterectomy Necessary?

ROBERT W. BARNES, M.D. AND PHYLLIS B. MARSZALEK, R.N.

SUMMARY This prospective study used non-invasive techniques to screen for asymptomatic carotid occlusive disease in 314 patients who were to have coronary or peripheral arterial reconstruction. Hemodynamically significant carotid obstruction ($\geq 50\%$ stenosis or occlusion) was present in 54 arteries of 41 patients (13.1%), but only one-third of these lesions were accompanied by a cervical bruit. Among 48 carotid arteries where a bruit was heard, only 18 (37.5%) were associated with significant obstruction demonstrated by non-invasive screening. No prophylactic carotid endarterectomies were performed. There was only one perioperative TIA and one non-fatal stroke, neither of which was related to detectable carotid obstruction. In patients with peripheral vascular disease and detectable carotid obstruction or bruit, the perioperative mortality was higher than in patients without carotid obstruction or bruit (15.0% and 18.2 vs 3.1% and 2.1%, respectively). The deaths were primarily due to myocardial infarction. This study suggests that asymptomatic carotid occlusive disease, while common in patients with other cardiovascular disease, does not necessarily predispose to perioperative stroke and thus does not necessitate prophylactic carotid endarterectomy prior to indicated coronary or peripheral vascular reconstruction.

Stroke, Vol 12, No 4, 1981

THERE ARE 3 categories of patients with asymptomatic carotid occlusive disease:¹ 1) patients with isolated asymptomatic carotid disease, usually manifested by a cervical bruit; 2) patients with an angiographically documented asymptomatic carotid lesion contralateral to symptomatic carotid disease; and 3) asymptomatic carotid disease in a patient who is a candidate for a major operation. While the role of prophylactic carotid endarterectomy in such patients remains controversial, patients in the third category are generally considered for prophylactic repair of the carotid lesion prior to a planned major surgical procedure.¹ Because a cervical bruit does not always correlate with severe carotid occlusive disease, non-invasive screening techniques have been advocated to define severe carotid obstruction in these patients.²⁻⁴ The role of such screening procedures and the efficacy of prophylactic repair of detected asymptomatic carotid lesions has not been established, even in patients who are candidates for a major operation.

This study was designed to use non-invasive diagnostic techniques to screen patients prospectively for the presence of asymptomatic carotid occlusive disease before planned coronary or peripheral artery reconstruction. It was initially designed to determine the efficacy of prophylactic carotid endarterectomy in a randomized trial of patients with detected severe carotid lesions. However, during the initial year of prospective screening to establish the prevalence of

asymptomatic disease, it was noted that patients who did not have prophylactic carotid endarterectomy for severe carotid lesions did not suffer perioperative transient ischemic attacks or stroke. This report reviews the initial 15 months of this surveillance program in which a consecutive group of patients having coronary or peripheral vascular reconstruction were screened for asymptomatic carotid occlusive disease but in whom no prophylactic carotid endarterectomies were performed prior to the intended surgery.

Materials and Methods

Diagnostic Techniques

All patients were examined with both indirect and direct non-invasive carotid screening techniques. Indirect or periorbital screening was carried out with a bi-directional Doppler ultrasonic velocity detector (Model D9, MedaSonics Inc., Mountain View, CA). The procedural details concerning this technique have been previously described.^{5, 6} The method involved determination of directional flow velocity in the branches of the ophthalmic artery and the responses to compression of the branches of each external carotid artery (superficial temporal, infraorbital and facial arteries). The accuracy of this technique compared to contrast arteriography can exceed 95% in the detection of severe stenosis (greater than 75% reduction in lumen diameter) or occlusion of the extracranial internal carotid artery.

Direct carotid screening was carried out with a bi-directional Doppler detector using an 8 megahertz probe. The method of audible assessment of carotid Doppler signals from the common, internal and external carotid arteries has been previously described.^{7, 8} The normal common carotid signal is smooth and pulsatile with prominent systolic and diastolic flow velocity. In the internal carotid artery the systolic and diastolic flow velocities are increased as a result of the low cerebrovascular resistance. The external carotid

From the Non-invasive Peripheral Vascular Laboratory, Department of Surgery, Medical College of Virginia, Virginia Commonwealth University, and the McGuire Veterans Administration Medical Center, Richmond, VA. Dr. Barnes is the David M. Hume Professor of Surgery; Miss Marszalek is research vascular technologist.

Presented in part at the 5th Joint Meeting on Stroke and Cerebral Circulation, Lake Buena Vista, FL, Feb. 21-23, 1980.

Supported by NIH Grant #5 R01 H L23568-02.

Reprints: Dr. Barnes, Box 221, MCV Station, Richmond, VA 23298.

artery signal is multiphasic with relatively low diastolic flow velocity as a result of the increased peripheral vascular resistance of the face and scalp. In the presence of carotid stenosis the velocity, and thus the pitch, of the Doppler signal is increased at the site of stenosis in proportion to the severity of the obstruction. Distal to a stenosis the carotid Doppler signal may assume a fluttering, bubbly or gruff characteristic as the result of disturbed or turbulent blood flow. In the presence of occlusion of a carotid segment, a flow signal may not be elicited at the expected location. Recently, the carotid Doppler signals have been analyzed with a real-time sound spectrum analyzer (AngioScan, Unigon Industries, Mount Vernon, NY).^{9, 10} The accuracy of the carotid audio Doppler examination, when compared to contrast arteriography, exceeds 90% in the detection of $\geq 50\%$ stenosis or occlusion of the internal carotid artery. The technique permits differentiation of internal carotid stenosis from occlusion with an accuracy exceeding 85%. Real-time spectral analysis of carotid Doppler signals permits detection of approximately 70% of carotid stenoses of less than 50% severity. Recently Blackshear et al. reported similar accuracy in the use of spectral analysis of carotid Doppler flow signals.¹¹

All non-invasive diagnostic studies were performed by a single experienced vascular technologist.

In addition to non-invasive Doppler studies, all patients were evaluated for the presence or absence of a cervical bruit. Auscultation for carotid bruits was carried out by surgical house officers who were unaware of the results of the Doppler evaluation.

Patients Studied

Candidates for this study included all patients who were to have coronary or peripheral arterial reconstruction at the Medical College of Virginia or the McGuire Veterans Administration Medical Center in Richmond. Patients were excluded from this study if they had a history of transient ischemic attack or stroke. Patients who had previous carotid endarterectomy were excluded. From March 1979 to June 1980, non-invasive evaluation of both carotid arteries of 314 patients was carried out. There were 273 men and 41 women studied who ranged in age from 33–90 years with a mean of 58.4 years. There were 261 white and 53 black patients. Hypertension was present in 135 patients and diabetes in 58. Seventy-two percent of the patients were active cigarette smokers. Of the 314 patients, 198 had angiographically proven coronary artery disease (CAD) and were candidates for coronary artery bypass. One hundred and sixteen had angiographic evidence of peripheral vascular disease (PVD) and required peripheral arterial reconstruction for aneurysmal or occlusive peripheral vascular disease manifested clinically by claudication, rest pain or gangrene.

Data Analysis

All patients were assessed for the presence of an asymptomatic cervical bruit and asymptomatic

carotid artery obstruction as shown by abnormal periorbital Doppler flow and/or abnormal audible carotid artery velocity signals in the neck. The prevalence of carotid artery obstruction associated with cervical bruit and, conversely, the prevalence of cervical bruit associated with carotid artery obstruction were determined. The incidence of perioperative transient ischemic attack, stroke or death related to stroke within 30 days of operation was assessed. Additionally, the incidence of perioperative death unrelated to stroke was determined.

Results

The table contains the results of carotid screening and postoperative outcomes of the 314 patients studied.

Asymptomatic Carotid Obstruction

Non-invasive periorbital and direct carotid Doppler screening detected significant obstruction in 54 carotid arteries of 41 patients (13.1% of 314 patients). Significant carotid disease was detected in 20 of 116 patients with PVD (17.2%) and 21 of 198 patients with CAD (10.6%). Severe bilateral stenoses were present in 6 patients with PVD and 7 patients with CAD. Of the 54 carotid arteries with significant obstruction, a bruit was present in 18 (33.3%), including 42.3% of the vessels in patients with PVD and 25% of the arteries of patients with CAD.

Asymptomatic Cervical Bruit

An asymptomatic cervical bruit was heard over 48 vessels of 34 patients (10.8%). Asymptomatic bruits were heard in 22 patients with PVD (19.0%) and in 12 patients with CAD (6.1%). Bilateral bruits were heard in 12 patients with PVD and two patients with CAD. Significant carotid obstruction was associated with a bruit in 11 of 34 vessels (32.4%) in patients with PVD and in 7 of 14 arteries (50%) in patients with CAD.

TABLE Results

| Diagnosis | Carotid Obstruction | No of Vessels | Carotid Bruit | No. of Vessels | Postop. Neurol. Deficit | Postop. Death |
|-----------|---------------------|---------------|---------------|----------------|-------------------------|---------------|
| | Present | 28 | Present | 7 | 0 | 1 |
| | n = 21 | | Absent | 21 | 0 | 0 |
| CAD | | | | | | |
| n = 198 | Absent | 368 | Present | 7 | 0 | 0 |
| | n = 177 | | Absent | 361 | 1 | 0 |
| | Present | 26 | Present | 11 | 0 | 2 |
| | n = 20 | | Absent | 15 | 0 | 1 |
| PVD | | | | | | |
| n = 116 | Absent | 206 | Present | 23 | 1 | 2 |
| | n = 96 | | Absent | 183 | 0 | 1 |

Perioperative Neurological Deficit

There were 2 neurologic complications within a 30-day period following operation. One patient after peripheral vascular reconstruction suffered a non-fatal stroke 2 weeks later. The patient had unilateral significant carotid obstruction but the stroke involved the hemisphere on the side opposite the carotid disease. One patient after coronary artery bypass was unresponsive for a period of 12 hours and had transient left hemiparesis. The patient was significantly hypotensive during the period of cardiopulmonary bypass. The patient did not have carotid bruits and had normal carotid arteries as ascertained by non-invasive Doppler evaluation.

Perioperative Mortality

There were 7 early postoperative deaths (2.2%). There was one death from myocardial infarction among the patients with CAD (0.5%) and 6 deaths among the patients with PVD (5.2%). All but 2 of the deaths were due to myocardial infarction. There were no stroke-related deaths. Of the 6 patients with PVD who died, all but one had evidence of carotid artery disease. The mortality rate for patients with significant obstruction or asymptomatic bruit (15.0% and 18.2%, respectively) was significantly higher than in patients without carotid obstruction or bruit (3.1% and 2.1%, respectively). The mortality for patients with PVD with a carotid obstruction and/or bruit, 14.7% (5 of 34) was significantly higher than for patients without evidence of carotid artery disease, 1.2% (1 of 82).

Discussion

The results of this study suggest that asymptomatic carotid artery disease is fairly common in patients who are candidates for coronary artery or peripheral vascular reconstruction. The prevalence of asymptomatic carotid bruit was significantly higher in patients with PVD (19.0%) than in patients with CAD (6.1%, $p < 0.005$). The presence of an asymptomatic bruit does not necessarily indicate significant obstruction of the carotid artery,² demonstrated by non-invasive screening in only 37.5% of vessels with a bruit. Conversely, significant carotid obstruction frequently occurs in the absence of a bruit,⁴ which was the case for two-thirds of the vessels with severe carotid obstruction in this study.

One of the important findings in this study was the fact that there was no instance of transient ischemic attack or stroke that was related to severe carotid obstruction, despite the fact that prophylactic carotid endarterectomy was not employed. The protective role of intraoperative anticoagulation with heparin in patients who are to have coronary artery bypass or peripheral vascular reconstruction cannot be ascertained from this study. The incidence of perioperative focal neurological deficit was low (0.6%). One transient ischemic attack and one non-fatal stroke were unrelated to significant carotid occlusive disease.

From this study it would appear that the presence of asymptomatic carotid artery disease does carry a risk of perioperative mortality, particularly of myocardial infarction, in patients with peripheral vascular disease. Patients with significant carotid obstruction and/or bruit had a significantly higher postoperative mortality rate (14.7%) than did patients without evidence of carotid artery disease (1.2%). It appears that the primary risk of detected asymptomatic carotid disease in a patient with PVD is the perioperative risk of myocardial infarction from associated coronary artery disease. This association of asymptomatic carotid disease with subsequent mortality from myocardial infarction was recently emphasized in the study of Heyman et al.¹² Although the presence of carotid bruit and/or obstruction may imply an increased risk of concomitant coronary artery disease there was no difference in age, incidence of angina or prior myocardial infarction in patients with or without carotid artery disease. Although routine non-invasive or invasive screening for coronary artery disease may be suggested for such patients, further studies of the natural history are necessary before considering prophylactic intervention on coronary artery disease in these patients.

The present study tends to support the recent findings of Turnipseed et al.¹³ who undertook independently a similar prospective study of patients undergoing coronary artery bypass or peripheral vascular reconstruction. They used non-invasive indirect and direct carotid screening techniques to assess 330 patients having coronary artery bypass or peripheral vascular reconstruction. Asymptomatic bruits were present in 44% of patients with PVD and 16% of patients with CAD. Significant carotid artery obstruction was identified in 39% of patients with PVD and 8% of patients with CAD. Prophylactic carotid endarterectomy was not performed in the study. Postoperatively only 3 of 16 neurologic complications occurred in patients with significant carotid obstruction, and only 3 of the neurologic deficits were focal in nature. Turnipseed et al. concluded that they could find no direct relationship between the presence of a carotid bruit, the severity of carotid disease and the incidence of perioperative stroke.

In the other categories of patients with asymptomatic carotid disease, there is little evidence in the literature suggesting a role for prophylactic carotid endarterectomy. Humphreys et al.,¹⁴ Johnson et al.¹⁵ and Podore et al.¹⁶ have reported on the natural history of asymptomatic carotid stenosis contralateral to operated symptomatic lesions. In all 3 studies the occurrence of stroke without antecedent transient ischemic attack in patients with asymptomatic carotid lesions which were not prophylactically removed was less than 5%. Between 3 and 17% of patients developed subsequent transient ischemic attacks requiring endarterectomy.

The occurrence of perioperative stroke in patients with asymptomatic carotid bruit is low. In reviewing the outcomes of 1082 patients having general surgical procedures in 3 reported series,¹⁷⁻¹⁹ the perioperative stroke rate was 1.0%. None of the 167 patients (15.4%)

with an asymptomatic carotid bruit suffered a post-operative stroke. Thus, there is little support in the literature for the current common practice of performing prophylactic carotid endarterectomy for patients with asymptomatic carotid lesions prior to major operative procedures.²⁰⁻²²

A major unanswered question is whether or not severe asymptomatic carotid disease poses a future risk of stroke in the late postoperative period. Cooperman et al.²³ noted a significantly greater risk of stroke in patients with a carotid bruit (9 of 60, 15%) than in patients without a bruit (7 of 196, 4%) 2 to 7 years after peripheral arterial reconstruction. Long-term follow up of the present series of patients is planned to define the incidence of stroke in those with and without detectable carotid occlusive disease. Such information will be necessary before the role of prophylactic endarterectomy for asymptomatic carotid disease²⁴ can be established.

This study suggests that asymptomatic carotid artery occlusive disease, as determined by indirect and direct carotid non-invasive screening techniques, is fairly common in patients who are candidates for coronary or peripheral vascular reconstruction. The prevalence of asymptomatic carotid disease is somewhat higher in patients with PVD than in patients with CAD. There is no good correlation between the presence of asymptomatic carotid bruit and significant obstruction of the carotid artery. In this study, two-thirds of the carotid arteries with significant obstruction did not have an associated carotid bruit. Conversely, nearly two-thirds of the carotid arteries with a bruit were not significantly obstructed as determined by non-invasive evaluation. There was no correlation between asymptomatic carotid occlusive disease and perioperative stroke. However, there was a significant correlation between asymptomatic carotid disease and postoperative mortality, particularly from myocardial infarction, in patients with PVD. These data do not support the practice of prophylactic carotid endarterectomy prior to coronary or peripheral vascular reconstruction. Long-term follow up of these patients will be necessary to establish the risk of transient ischemic attack or stroke in the late post-operative period.

Acknowledgment

The authors appreciate the assistance of S. James Kilpatrick, Ph.D., for biostatistical design of this study, Phillip Pollack, M.S., for development of a data base program, and C. Louise Kirk, M.S., for help in data collection.

References

- Fields WS: Current concepts of cerebrovascular disease: The asymptomatic carotid bruit — Operate or not? *Stroke* 9: 269-271, 1978
- Kartchner MM, McRae LP: Noninvasive evaluation and management of the "asymptomatic" carotid bruit. *Surgery* 82: 840-847, 1977
- Brewster DC, Abbott WM, Darling RC et al: Noninvasive evaluation of asymptomatic carotid bruits. *Circulation* 58 (suppl I): I-5-9, 1978
- Barnes RW: Noninvasive evaluation of the carotid bruit. *Ann Rev Med* 31: 201-218, 1980
- Barnes RW, Wilson MR: Doppler Ultrasonic Evaluation of Cerebrovascular Disease: A Programmed Audiovisual Instruction. Iowa City, University of Iowa, pp 196, 1975
- Barnes RW, Russell HE, Bone GE et al: The Doppler cerebrovascular examination: Improved results with refinements in technique. *Stroke* 8: 468-471, 1977
- Barnes RW, Rittgers SE, Thornhill B et al: Noninvasive determination of carotid artery operability by Doppler ultrasound. *Va Med* 106: 804-808, 1979
- Rittgers SE, Barnes RW: Doppler Ultrasonic Evaluation of Carotid Velocity Signals: An Audio Instruction. Richmond, Virginia Commonwealth University, p 30, 1980
- Rittgers SE, Putney W, Barnes RW: Real-time spectral analysis and display of Doppler signals. *Proc Ann Conf Engin Med Biol* 32: 90, 1979
- Rittgers SE, Barnes RW: Doppler Ultrasonic Spectrum Analysis of Carotid Velocity Signals: An Audio Visual Instruction. Richmond, Virginia Commonwealth University, p 54, 1980
- Blackshear WM, Phillips DJ, Thiele BL et al: Detection of carotid occlusive disease by ultrasonic imaging and pulsed Doppler spectrum analysis. *Surgery* 86: 698-706, 1979
- Heyman A, Wilkinson WE, Heyden S et al: Risk of stroke in asymptomatic persons with cervical arterial bruits: A population study in Evans County, Georgia. *N Engl J Med* 302: 836-841, 1980
- Turnipseed W, Berkoff H, Belzer FO: Postsurgical stroke in cardiac and peripheral vascular disease. *Ann Surg* 192: 365-368, 1980
- Humphries AW, Young JR, Santilli PH et al: Unoperated, asymptomatic significant internal carotid artery stenosis: A review of 182 instances. *Surgery* 80: 695-698, 1976
- Johnson N, Burnham SJ, Flanigan DP et al: Carotid endarterectomy: A follow-up study of the contralateral non-operated carotid artery. *Ann Surg* 188: 748-752, 1978
- Podore PC, DeWeese JA, May AG et al: The asymptomatic contralateral carotid artery stenosis: A five-year follow-up study following carotid endarterectomy. *Surgery* 88: 748-752, 1980
- Treiman RL, Foran RF, Shore EH, et al: Carotid bruit: Significance in patients undergoing an abdominal aortic operation. *Arch Surg* 106: 803-805, 1973
- Carney WI, Stewart WB, DePinto DJ et al: Carotid bruit as a risk factor in aortoiliac reconstruction. *Surgery* 81: 567-570, 1977
- Evans WE, Cooperman M: The significance of asymptomatic unilateral carotid bruits in preoperative patients. *Surgery* 83: 521-522, 1978
- Bernhard VM, Johnson WD, Peterson JJ: Carotid artery stenosis: Association with surgery for coronary artery disease. *Arch Surg* 105: 837-840, 1972
- Lefrar EA, Guinn GA: Prophylactic carotid artery surgery in patients requiring a second operation. *South Med J* 67: 185-189, 1974
- Hertzner NR, Loop FD, Taylor PC et al: Staged and combined surgical approach to simultaneous carotid and coronary vascular disease. *Surgery* 84: 803-811, 1978
- Cooperman M, Martin EW, Evans WE: Significance of asymptomatic carotid bruits. *Arch Surg* 113: 1339-1340, 1978
- Thompson JE, Patman RD, Talkington CM: Asymptomatic carotid bruit: Long-term outcome of patients having endarterectomy compared with unoperated controls. *Ann Surg* 188: 308-316, 1978