Indication for Carotid Endarterectomy

Isao YAMAMOTO, Hiroshi KANNO, and Satoshi FUJII

Department of Neurosurgery, Yokohama City University School of Medicine, Yokohama

Abstract

From recent randomized studies, carotid endarterectomy (CEA) is highly beneficial to the patients with a symptomatic high-grade carotid artery stenosis (70–99%), but the surgical indication for an asymptomatic carotid artery disease remains unsolved. Sixty-three atheromatous plaques (symptomatic 51, asymptomatic 12) were obtained from 57 patients who underwent CEA. The presence of an intraplaque hemorrhage was noted in 75% from symptomatic plaques, compared with 33% from asymptomatic ones. A plaque disruption occurred over protruding mounds of intraplaque hemorrhage and was noted in 76% and 42% from symptomatic and asymptomatic ones, respectively. However, asymptomatic plaques, which were angiographically demonstrated as carotid ulcer of types B and C, had a high incidence of intraplaque hemorrhage as well as plaque disruption. Three patients followed with asymptomatic contralateral carotid artery disease developed a stroke following ipsilateral revascularization and all three specimens showed the presence of plaque hemorrhage and disruption. It is concluded that before prophylactic CEA is considered, an intraplaque hemorrhage and/or plaque disruption should be detected by less invasive procedures such as ultrasonography.

Key words: carotid endarterectomy, intraplaque hemorrhage, plaque disruption, surgical indication

Introduction

From three randomized cooperative trials in 1991, that is, North American Symptomatic Carotid Endarterectomy Trial (NASCET),¹⁸⁾ European Carotid Surgery Trial (ECST),⁷⁾ and Symptomatic Carotid Stenosis Veterans Administration Trial,¹⁴⁾ carotid endarterectomy (CEA) is beneficial to the patients with a symptomatic 70–99% stenosis of the carotid artery. However, the surgical indications of CEA for ulceration, tandem stenosis, asymptomatic carotid artery disease, or contralateral carotid artery lesions are still controversial. Recently, clinicopathological studies of carotid atheroma have implicated intraplaque hemorrhage and plaque disruption as an etiological factor in symptomatic carotid artery stenosis.^{1,9,10,12,13,20)}

In this paper, we studied a clinicopathological examination of atheromatous plaques and discussed about the indication for CEA, particularly in an asymptomatic carotid artery disease from the pathological viewpoint.

Materials and Methods

Sixty-three atheromatous plaques were obtained from 57 patients who underwent CEAs, on 41 males

and 16 females, with a mean age of 63 years. CEA for symptomatic plaques are 51, which included carotid artery stenosis in 26, ulcer in 18, and stenosis and ulcer in seven on angiogram. Among the remaining 12 asymptomatic plaques, angiograms demonstrated carotid artery stenosis of 70% or greater in five and carotid ulcer in seven. Surgically removed carotid plaques were studied macroscopically and the presence of intraplaque hemorrhage and/or disruption of the intimal plaque surface were assessed by light microscopy.

Results

Examination of the symptomatic group revealed 38 of 51 (75%) to have an intraplaque hemorrhage. In the asymptomatic group, four of 12 (33%) showed an evidence of intraplaque hemorrhage. Plaque disruption was present in 39 of 51 (76%) symptomatic carotid plaques, compared with 42% (5 of 12) of asymptomatic ones. In 26 plaques with a symptomatic carotid artery stenosis (50–99%) on angiogram, the presence of intraplaque hemorrhage was noted in 81% (21 of 26) and that of plaque disruption in 69%. Among 22 plaques with greater than 70% stenosis, 21 had an intraplaque hemorrhage. In 18 plaques with an angiographically proven symptomatic

Table 1 Correlation between angiographic and pathological findings in 51 symptomatic plaques

Angiographic findings	Intraplaque hemorrhage	Plaque disruption
Stenosis (n = 26)	21	18
Ulcer (n = 18)	12	15
A* (n = 0)	0	0
B* (n = 10)	7	9
C* (n = 8)	5	6
Stenosis and ulcer (n = 7)	5	6
Total (n = 51)	38	39

*According to Moore's classification.¹⁶⁾ n: no. of plaques.

Table 2 Correlation between angiographic and pathological findings in 12 asymptomatic plaques

Angiographic findings	Intraplaque hemorrhage	Plaque disruption
Stenosis (70% or greater) (n = 5)	1	0
Ulcer (n = 7)	3	5
A* (n = 1)	0	0
B* (n = 4)	1	3
C* (n = 2)	2	2
Total (n = 12)	4	5

*According to Moore's classification.¹⁶⁾ n: no. of plaques.

carotid ulcer, 67% (12 of 18) had an evidence of intraplaque hemorrhage and 83% had plaque disruption (Table 1). In seven plaques with a symptomatic carotid artery stenosis and ulcer, the presence of intraplaque hemorrhage and plaque disruption was 71% and 86%, respectively. Although all asymptomatic specimens in carotid ulcer of type C according to Moore's classification¹⁶⁾ revealed not only intraplaque hemorrhage but also plaque disruption, the frequency of these pathological findings in the remaining 10 asymptomatic plaques when compared with the frequency of symptomatic plaques was significantly low (Table 2).

Discussion

The benefit of CEA for symptomatic patients with 70–99% carotid artery stenosis has been emphasized now in three randomized cooperative trials.^{7,14,18)} The continuing controversy over asymptomatic carotid artery disease has spawned several large clin-

ical trials. Carotid Artery Stenosis with Asymptomatic Narrowing Operation Versus Aspirin Study (CASANOVA)⁵⁾ did not show any favorable results in morbidity and mortality following CEA in patients with asymptomatic carotid artery stenosis of less than 90%. The Mayo Asymptomatic Carotid Endarterectomy Trial (MACE)¹⁵⁾ did not reveal the benefit of CEA for symptomatic patients, but this study had a serious problem because the baseline therapy was not identical in medical and surgical groups. The Veterans Administration Cooperative Trials¹¹⁾ reported that CEA reduced the overall incidence of ipsilateral neurological events in patients with asymptomatic carotid artery stenosis of 50% or more, but this trial did not show any significant effect from CEA on the combined incidence of stroke and death. The European Carotid Surgery Trial (ECST)⁸⁾ also reported that the potential benefit of CEA for asymptomatic carotid artery stenosis is small. The Asymptomatic Carotid Artery Study (ACAS)^{2,3)} is still in progress and does not conclude whether the CEA fares better than the medical therapy.

Many prospective studies, which correlated the carotid plaque pathology with the preoperative symptoms, indicated that the occurrence of an intraplaque hemorrhage and a plaque disruption was an important finding in the development of cerebral ischemia. Our results demonstrate a significantly increased frequency of intraplaque hemorrhage as well as plaque disruption in symptomatic CEA specimens, particularly of patients with greater than 70% stenosis and type B and C carotid ulcers, when compared with asymptomatic specimens. Therefore, CEA is indicated for patients with severe symptomatic carotid artery stenosis and major ulcer. Moore et al.¹⁶⁾ examined 67 patients with asymptomatic ulcers and reported that an annual stroke rate of type A and, type B or C ulcers were 0.4% and 12.5%, respectively. Our study indicates asymptomatic plaques with type B and C ulcers have a high incidence of intraplaque hemorrhage and plaque disruption. From these results, a prophylactic CEA may be justified in these major ulcers without ischemic symptoms.

Patients with significant asymptomatic carotid plaque who have had contralateral carotid artery surgery for a symptomatic lesion are at high risk for future ischemia in all vessel territories.⁶⁾ In our series, four patients with symptomatic occlusion of internal carotid artery or carotid siphon stenosis with contralateral carotid ulcer had extracranial-intracranial (EC-IC) bypass procedures for symptomatic side. However, after EC-IC bypass, three patients developed an ischemic symptom referable to the previously asymptomatic carotid ulcer, probably due

to postoperative hemodynamic changes, and all three surgical specimens showed an intraplaque hemorrhage.^{21,22)} So prophylactic CEA following EC-IC bypass surgery may also be indicated for a contralateral asymptomatic major carotid ulcerative lesion.

Numerous studies have been done recently using Doppler ultrasonography to determine the characteristics of carotid plaque preoperatively. Bluth et al.⁴⁾ reported the accuracy of identifying the presence of intraplaque hemorrhage with ultrasonography was 90%. Johnson also described that patients with soft heterogeneous plaques, which contained either intraplaque hemorrhage or cholesterol lakes, have a high incidence of ischemic events when followed prospectively.¹⁹⁾ So before prophylactic CEA is considered, this less invasive test should be performed for the detection of intraplaque hemorrhage.

With the development of recent imaging techniques, asymptomatic carotid artery lesions can be easily identified. Although it is well known that there are several anatomical and pathological differences of carotid atherosclerosis between Japanese and American peoples,¹⁷⁾ no randomized clinical study is performed in our country. Therefore, it is hoped that this report will stimulate interest and further study of the Japanese Carotid Surgery Trials for an asymptomatic carotid artery disease.

Although no firm conclusions can be drawn from this small series, our recommendations for the management of asymptomatic carotid artery lesions are as follows: 1) Patients with severe carotid artery stenosis (greater than 70%) or evidence of major ulcerative disease (type B or C) should undergo ultrasonography. This less invasive detection of an intraplaque hemorrhage requires prophylactic CEA, if there are no specific contraindications; 2) CEA is recommended for medically stable patients who angiographically have contralateral major ulcerative lesions; and 3) Patients with moderate carotid artery stenosis or minor ulcer should be followed with serial clinical and less invasive evaluations.

References

- 1) Ammar AD, Wilson RL, Travers H, Lin JJ, Farha SJ, Chang FC: Intraplaque hemorrhage: its significance in cerebrovascular disease. *Am J Surg* 148: 840-843, 1984
- 2) The Asymptomatic Carotid Atherosclerosis Study Group: Study design for randomized prospective trial of carotid endarterectomy for asymptomatic atherosclerosis. *Stroke* 20: 844-849, 1989
- 3) Barnett HJM, Taylor DW: Clinical trials in stroke prevention — persisting uncertainties, firm answers. *Neurology* 43: 2163-2166, 1993
- 4) Bluth EI, Kay D, Merritt CRB, Sullivan M, Farr G, Mills NL, Foreman M, Sloan K, Schlater M, Stewart J: Sonographic characterization of carotid plaque: Detection of hemorrhage. *AJNR Am J Neuroradiol* 7: 311-315, 1986
- 5) The CASANOVA Study Group: Carotid surgery versus medical therapy in asymptomatic carotid stenosis. *Stroke* 22: 1229-1235, 1991
- 6) Durward QJ, Ferguson GG, Barr HW: The natural history of asymptomatic carotid bifurcation plaques. *Stroke* 13: 459-464, 1982
- 7) European Carotid Surgery Trialists' Collaborative Group: MRC European Carotid Surgery Trial: Interim results for symptomatic patients with severe (70-99%) or with mild (0-29%) carotid stenosis. *Lancet* 337: 1235-1243, 1991
- 8) The European Carotid Surgery Trialists' Collaborative Group: Risk of stroke in the distribution of an asymptomatic carotid artery. *Lancet* 345: 209-212, 1995
- 9) Fisher CM, Ojemann RG: A clinico-pathological study of carotid endarterectomy plaques. *Rev Neurol* 142: 573-589, 1986
- 10) Fisher M, Blumenfeld AM, Smith TW: The importance of carotid artery plaque disruption and hemorrhage. *Arch Neurol* 44: 1086-1089, 1987
- 11) Hobson RW 2d, Weiss DG, Fields WS, Goldstone J, Moore WS, Towne JB, Wright CB: Efficacy of carotid endarterectomy for asymptomatic carotid stenosis. *N Engl J Med* 328: 221-227, 1993
- 12) Imparato AM, Riles TS, Gorstein F: The carotid bifurcation plaque: Pathologic findings associated with cerebral ischemia. *Stroke* 10: 238-245, 1979
- 13) Lusby RJ, Ferrell LD, Ehrenfeld WK, Stoney RJ, Wylie EJ: Carotid plaque hemorrhage; its role in production of cerebral ischemia. *Arch Surg* 117: 1479-1488, 1982
- 14) Mayberg MR, Wilson SE, Yatsu F, Weiss DG, Messina L, Hershey LA, Colling C, Eskridge J, Deykin D, Winn HR: Carotid endarterectomy and prevention of cerebral ischemia in symptomatic carotid stenosis. *JAMA* 266: 3289-3294, 1991
- 15) Mayo Asymptomatic Carotid Endarterectomy Study Group: Results of a randomized controlled trial of carotid endarterectomy for asymptomatic carotid stenosis. *Mayo Clin Proc* 67: 513-518, 1992
- 16) Moore WS, Boren C, Malone JM: Natural history of nonstenotic, asymptomatic ulcerative lesions of the carotid artery. *Arch Surg* 113: 1352-1359, 1978
- 17) Mori K: [Carotid endarterectomy]. *No Socchu* 10: 481-490, 1988 (Jpn, with Eng abstract)
- 18) North American Symptomatic Carotid Endarterectomy Trial Collaborators: Beneficial effect of carotid endarterectomy in symptomatic patients with high-grade carotid stenosis. *N Engl J Med* 325: 445-453, 1991
- 19) Persson AV: Intraplaque hemorrhage. *Surg Clin North Am* 66: 415-520, 1986
- 20) Persson AV, Robichaux WT, Silverman M: The natural history of carotid plaque development. *Arch Surg* 118: 1048-1052, 1983

- 21) Yamamoto I: [Asymptomatic carotid stenosis and ulcer. From surgical viewpoint]. *Rinsho Seijinbyo* 24: 190-195, 1994 (Jpn)
- 22) Yamamoto I, Ikeda A, Shibuya N, Tsugane R, Sato O: [Carotid endarterectomy for intracranial and extracranial multiple stenotic lesions]. *Surgery for Cerebral Stroke* 16: 372-377, 1988 (Jpn, with Eng abstract)

Address reprint requests to: I. Yamamoto, M.D., Department of Neurosurgery, Yokohama City University School of Medicine, 3-9 Fukuura, Kanazawa-ku, Yokohama 236-0004, Japan.