Ischemic cerebrovascular disease, a major public health problem, is accompanied, and possibly caused in a large percentage of cases, by extracranial arterial lesions. A rapidly expanding body of surgical literature records the success of procedures designed to repair these lesions along with a decline in recent years in surgical mortality for such procedures. If an area of carotid abnormality is a constant threat to adequate cerebral blood flow, why not remove it? There is no fully documented analysis of replies to this important question, but the present view addresses five areas of study that may result in a postponement or rejection of the decision to operate. These areas are not mutually exclusive; rather, they are variables that interact and should be considered in conjunction.

1. Availability of Nonsurgical Prophylactic Treatment

There is little evidence that surgical or medical treatment produces major reversals in deficits of cerebral function already caused by cerebral infarction. Treatment is primarily directed toward prevention of future ischemic episodes. At the present time two medical treatments are available: anticoagulants and platelet aggregation inhibiting agents. No justice can be done here to the massive body of literature on prophylactic results with these agents; however, discussion of the surgical decision would be incomplete without a brief comment on the current status of medical treatment.

Despite decades of study, the place of anticoagulants in ischemic cerebrovascular disease remains uncertain. Although several studies have reported the success of these agents in preventing further ischemic attacks, there are only four well-designed prospective controlled studies. One major problem, as in most studies of treatment of this condition, has been that of properly defining controls. All patients with transient ischemic attacks are not alike. The large number of variables that should be considered in stratifying patients has been thoughtfully discussed by Brust, but no study has done this stratification completely. Uncertainty persists as to the actual prognosis in various types of TIA patients. In one recent follow-up study of 314 patients with TIAs, there was an amazingly low occurrence of 4.8% brain infarction in their patients, only 3.5% of whom had had carotid endarterectomy. The authors postulate that the favorable prognosis may have been due to a more youthful group of patients. In a 1975 review of the older studies on the use of anticoagulants in TIAs, Kuller concluded that the randomized studies showed a decrease in the frequency of TIAs and a small decrease in the number of completed strokes and stroke-related deaths.

Despite a decline in popularity of anticoagulants, several recent studies have reported favorable prophylactic effects. Link et al., using anticoagulants in 117 cases of TIA or cerebral infarction (combined with carotid endarterectomy in 41 suitable cases), noted subsequent cerebral infarction in only one patient during a mean follow-up period of 11 months. A comparative study by Olsson et al. of anticoagulant and antiplatelet therapy in 135 cases of TIA or RIND demonstrated only one case of cerebral infarction in 68 patients on anticoagulants in a 12-month follow-up. Particular importance has been given to the use of anticoagulants in the period immediately after TIA or RIND. In summary, anticoagulation remains a viable alternative, particularly on a short-term basis, but there is still uncertainty about its role vis-a-vis surgery and the treatments discussed below. One recent randomized study of anticoagulants and platelet aggregation inhibitors in TIA patients found only 3.3% of anticoagulated patients to have sustained cerebral infarction during a two-year follow-up.

More interest in recent years has centered on the use of the antiplatelet-aggregating agents, such as aspirin, dipyridamole, and sulfynpyrazone, in ischemic cerebrovascular disease. Four prospective controlled studies summarized by Dyken in 1979 reported decrease in transient ischemic attacks, cerebral infarction, and death in the groups treated with aspirin, and two more recent studies support these results. The effectiveness of other antiplatelet agents in this area has not been extensively studied. Several cases of increasing atherosclerotic arterial disease in patients under aspirin therapy have recently been reported, and it has been suggested that the drug may conceal the symptoms of progressive damage to extracranial arteries. There is no published study comparing surgical and platelet-aggregation inhibition treatment of ischemic cerebrovascular disease, nor is there a study of the clinical and angiographic characteristics of patients in whom the antiplatelet agents either failed or succeeded in preventing further ischemic episodes.

In summary, at present, when carotid endarterectomy for prophylaxis of ischemic cerebrovascular disease is considered, its risk-benefit must be weighed...
against the two nonsurgical treatments, although their efficacy in relation to each other and to surgical treatment remains largely unknown.

II. Age

Given the possibility of surgical or nonsurgical treatment, to what degree is age of the patient a contraindication to operation? Increasing numbers of patients in the eighth, ninth, and tenth decades of life are being evaluated for these problems. The incidence of cerebral infarction rises with age, reaching a level of 25 per 1,000 in the 75 to 84 age group. 10 Harbrecht et al. in a recent review commented: "The majority of serious problems in some operations occurred in patients over 75. The projected increase in that age group by the year 2000 is 60% compared to a projected increase of only 25% in those aged 65 to 74."

How much is advanced age a contraindication to the carotid operation? We have little data with which to answer this question. Average life expectancy now for the 75-year-old is ten years, for the 80-year-old seven and a half years. Poor results in surgical procedures in general are not reported as directly related to the ages of patients. 12 On the other hand, the aged frequently have multiple diseases, notably cardiac, and cerebral blood flow is reduced. Furthermore, a recent study describes the frequent failure of autopsies to account for death in the very aged and points out the occurrence of "debility and death of older persons from causes that would not have had serious consequences at younger ages. This phenomenon can be understood on the basis of the universal progressive decline in the function of physiological processes with increasing age."

There is little specific information on advanced age as a risk factor in carotid artery surgery. In 1979 Ranson et al. found a 10% rate of myocardial infarction and 20% of moderate or severe new strokes in their operated patients aged 70 or older. 14 Sundt et al. identified as a "major medical risk" age of over 70. 15

III. Concomitant Medical Disease

Medical conditions may impinge on the endarterectomy decision in two ways: (a) the risk in the perioperative and immediate postoperative period may be prohibitively increased, and (b) the prognosis for long-term good health may be poor.

The usual problem is accompanying cardiac disease. Concerning the long-term prognosis, numerous follow-up studies of TIA patients have reported a high rate of death from myocardial infarction. 16 As Ennix et al. recently pointed out, "The natural histories of carotid and coronary artery occlusive diseases are certainly intertwined." 17 Whether symptomatic atherosclerotic heart disease is of such a degree as to make operation on a diseased carotid not worth while is rarely discussed. Likewise, whether the option of multiple operations (e.g., carotid-coronary) will alter these decisions in the future is at present not known.

The perioperative surgical mortality in patients known to have coronary disease has been very high; in one recent series of patients with cardiac symptoms, it was 18.2%. 17 It is also well known that the risk of perioperative stroke is increased in these patients. Two comparatively new developments, however, are reported to affect operative risk.

First, the preparation for carotid surgery by preliminary or concomitant coronary bypass of patients who are known to have cardiac disease has been reported to lower mortality markedly. 17 It is apparent that the transient ischemic attack is probably as much a warning in the elderly of generalized, but particularly coronary, arterial disease as it is of carotid-vertebral disease. In the absence of overt cardiac disease, should patients have coronary angiography prior to carotid endarterectomy? Certainly, with the known high risk of myocardial infarction in this population, advanced coronary artery disease might well be demonstrated in many such patients and would raise the question of prophylactic coronary artery surgery.

The second new development promising decreased risk to patients with cardiac disease is the particular and meticulous attention to cardiopulmonary function during the operative period by a team that includes a cardiologist. 18

Despite these advances in care of patients with known cardiac disease, the degree of increased risk will clearly contraindicate operation in some individuals. In long-term follow-up of patients with TIA, as noted previously, the most frequent cause of death is myocardial infarction; other cardiovascular disease is, of course, also common.

In determining the patient's over-all prognosis, hypertension is also an important prognostic feature. It is associated with diminished survival rates undoubtedly because of concomitant cardiac disease. One recent study showed that a history of hypertension was a more reliable prognostic factor than the finding of an elevated blood pressure at the time of admission.

IV. Arterial Lesions of Questionable Relevance to the Patient's Clinical State

Problems abound in the decision about carotid endarterectomy when a significant carotid lesion is identified on the same side as the patient's transient hemispheric dysfunction. What should be done when a carotid lesion is discovered in a patient without TIA, or whose TIA does not clinically "fit" the diseased artery? This question includes several clinical-angiographic problems:

1. The asymptomatic patient with a carotid bruit who is found to have a carotid lesion on angiography. The prognosis of these patients has been studied in several series, 19 and there is a definite discrepancy of opinion. Although several studies have documented an increased incidence of cerebral infarction in these patients, the strokes have not been consistently related to the artery producing the bruit. 20 Again, there are no data comparing medical and surgical treatment.

2. The patient with only vertebobasilar TIA who on angiography has only a carotid lesion. This problem also has not been extensively studied. If the attacks are
definitely vertebrobasilar in nature, it seems probable that the carotid lesion was a coincidental finding and there is no guarantee of benefit from surgery.

3. The patient with carotid TIAs who is found to have a lesion only on the "incorrect" or opposite side.

4. The patient with consistently unilateral TIAs who has bilateral carotid lesions.

The only evidence on these subjects is a follow-up of patients who have had carotid endarterectomy of a "symptomatic" lesion in the presence of a known "asymptomatic" one. Recurrent episodes on the endarterectomized side are as frequent as those referable to the previously asymptomatic carotid lesion (opposite side). In general, then, the more "inappropriate" the carotid lesion is to the nature of the patient's attacks, the less efficacious is surgery as prophylaxis and the more dubious the benefit-risk ratio.21, 22

5. Patients with an occluded internal carotid with a contralateral "appropriate" carotid stenosis or vice versa.

There is almost universal agreement at present that operation on an occluded carotid artery in the presence of an acute stroke is contraindicated. Functional restoration of flow in any totally occluded artery is apparently difficult. It would seem that restoring flow to the hemisphere by opening an occluded carotid might provide insurance against further ischemia. Whether the procedure does so, however, has not been established. Furthermore, there is evidence that spontaneous recanalization of occluded carotid arteries occurs.23

Accurate decisions in these five types of patients obviously would demand meticulously designed studies of huge groups of patients. It is not surprising therefore that at present only fragmentary evidence is available.

V. Severity of Neurological Deficit

Ischemic cerebrovascular disease occurs primarily in the elderly, and in the decision to operate on a diseased carotid artery, concomitant neurological disease should be evaluated.

Although patients with minor neurological deficits from previous infarcts or hemorrhages should not be disqualified from surgery, the risk-benefit ratio would probably contraindicate operation in those with, for example, global aphasia and dense hemiplegia. The degree of deficit that would make operation not "worthwhile," such as aphasia alone or severe ataxia, has not been thoroughly discussed. Patients with multi-infarct dementia, impairment of mental status as a sequel to repeated infarcts, would not seem to warrant surgery.

Among other common accompanying diseases, Alzheimer's disease is of note because of its extreme frequency in the elderly. It is generally relentlessly progressive, leading to severe dementia, and when it occurs in association with carotid disease, the condition clearly would contraindicate operation. The same caution applies, of course, to other progressive neurological diseases, one group of which, brain neoplasia, is occasionally misdiagnosed as ischemic cerebrovascular disease.

In summary, lesions of the extracranial carotid arteries usually occur in patients with a variety of problems that may influence the decision to operate. There is at present no formula for assessing the importance of any single problem or of several in combination in making this decision.

References

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