Report on the Cooperative Study of Intracranial Aneurysms and Subarachnoid Hemorrhage

SECTION VIII, Part 1

Results of the Treatment of Intracranial Aneurysms by Occlusion of the Carotid Artery in the Neck

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Introduction

Oclusion of the cervical portion of the carotid artery has been employed since 1885 as a definitive treatment for intracranial aneurysm. The resultant reduction of intra-arterial pressure is expected to reduce the likelihood of subsequent hemorrhage. The alteration of blood flow characteristics within the aneurysmal sac may encourage thrombosis with organization and fibrosis, which would strengthen the wall or obliterate the sac. That pressure can be reduced effectively in the internal carotid artery by proximal internal or common carotid occlusion has been substantiated amply by the works of many authors. However, pressure reductions distal to the bifurcation of the internal carotid artery following carotid occlusion in the neck were doubted until Bakay and Sweet '52 measured by direct cannulation the intravascular pressures in distal arteries at craniotomy. They found that the pressure reductions beyond the bifurcation of the internal carotid were equivalent to those obtained in the cervical portion of the carotid immediately distal to the site of occlusion. While late postocclusion studies by direct cannulation and recording have been difficult to carry out, ophthalmodynamometry has provided a practical means of estimating the relative pressure decrements.

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In a late postoperative study of retinal artery pressures in 13 patients with carotid ligation, Christiansson '62 found eight patients who had maintained pressure drops of 20 per cent or more over a period of from 1 to 13 years. The observation that there was stasis of blood within the aneurysmal sac after carotid occlusion was made at angiography by Ecker and Riemenschneider '51. During digital carotid occlusion, they found that Diodrast remained within the sac for over a minute, and, in the same patient, angiography performed one week after partial occlusion of the common carotid by a tantalum clip showed no filling of the aneurysm.

Aneurysms may decrease visibly in size or become progressively thrombosed after carotid ligation. Logue (quoted by Ecker and Riemenschneider) operated intracranially upon three patients a week after he had ligated their carotid arteries, and found that in each case, the aneurysm was firm to palpation. Furthermore, needle aspiration yielded no blood. Mount and Taveras '56, and Odom et al. '62 have reported upon series of late postocclusion angiographic studies, revealing either a decrease in size or nonvisualization of the original aneurysm in a large proportion of cases. Mount '59, however, pointed out the need for caution in interpreting nonvisualization of the aneurysm by angiography as a definite sign of thrombosis, for one of his patients rebled from an aneurysm which had failed to fill postoperatively, even though the parent vessel from which it arose was visualized. He noted, further, that two of his patients bled for the first time after carotid occlusion.

Histological investigations by Hassler '63 on the effects of carotid ligation on the circle of Willis of rabbits revealed a change in the
distribution and severity of medial defects and of intimal cushions as well as an increase in the size of the unoccluded carotid artery. The uncertainty regarding the individual degree of protection offered by the procedure against subsequent aneurysmal rupture, the late effects upon the remaining carotid, and the possible late ischemic effects which might become manifest if and when the remaining carotid became narrowed or occluded by atheroma, plus the morbidity and mortality of the procedure itself, have often made carotid occlusion a treatment of second choice or even excluded it altogether from the armamentarium of many neurosurgeons.

Although the literature of the past ten years has been increasingly concerned with newer techniques for intracranial operation, several reports of large series indicated that in many major centers carotid occlusion is still used extensively in the treatment of intracranial aneurysm. Considerable differences are noted in the results reported from these centers. Such disparity would not be expected on the basis of the surgeons’ technical skill since the procedure is uniformly simple and applies minimal stress to the patient. Jefferson '51 reported an 86 per cent survival in 142 ligated patients after one to six years, and Poppen and Fager '60 reported a 79 per cent survival in 101 ligated patients after 1 to 15 years. The authors of each report specified that the ligations were performed primarily for internal carotid aneurysms. The majority of the patients in the series of Poppen and Fager had occlusion of the internal carotid artery and over one-half of them were operated upon more than one month after their subarachnoid hemorrhage. In contrast, Mount '59 reporting upon a series of 65 patients, 55 of whom received internal carotid occlusion or its equivalent (external plus common carotid) at an average interval of 35 days from the last hemorrhage, achieved satisfactory results in terms of survival and function in only 40 per cent; these results were disappointing for a series of selected cases.

McKissock et al. '60 reported a survival rate of 72 per cent in 266 patients with common carotid ligation; in an earlier article, McKissock et al. '56 revealed that approximately 35 per cent of their patients were being operated upon within 10 days of their most recent hemorrhage. These authors have uniformly categorized the clinical state of their patients at the time of operation, a feature noticeably lacking from earlier reports of the results of surgical treatment. Norlén '52 reporting on a smaller group of 31 patients, found a survival of 23 over a 14-year postoperative study. Both he and Mount '59 noted a striking incidence of recurrent hemorrhage in their cases. In a carefully-detailed study of 54 ligated patients, Hardy et al. '58 noted a survival of 87 per cent over 1 to 13 years; three patients died of recurrent hemorrhage. In a re-evaluation of a series of 35 patients, German and Black '65 found that four of the 27 survivors first reported on in 1953 had died in the intervening decade. One of these patients died of a ruptured anterior communicating aneurysm (previously undiagnosed) and two of questionable subarachnoid hemorrhages. The fourth patient died of thrombosis of the unligated carotid artery.

Modifications in technique have been designed to reduce the morbidity resulting from ischemia of the hemisphere ipsilateral to carotid occlusion. Temporary manual compression of the carotid artery (Matas test) has given some indication of the adequacy or inadequacy of collateral circulation. However, the ability to tolerate such compression for five or ten minutes does not guarantee that there will be no ischemic complications after ligation of the artery, nor does the inability to tolerate compression necessarily mean that gradual surgical occlusion cannot be performed without complication. While measurements of the reductions in pressure and blood flow may indicate the relative potential for ischemic damage, it has not been possible to predict accurately how much pressure or flow decrease may be tolerated by a given individual. The use of intermittent digital occlusion prior to ligation to encourage the development of collateral circulation was strongly advocated by Dandy '42; he also performed two-stage occlusions, partially occluding the artery in the first stage and totally ligating it later. Of seven patients so treated, none developed ischemic complications. The use of adjustable clamps of the Poppen-Blalock, Selverstone, Crutchfield, and similar type have provided a means of occluding gradually and controllably the artery over a period of hours or days, and of rapidly releasing the occlusion at the bed-