CHANGES IN INTERNAL CAROTID PRESSURE DURING CAROTID AND JUGULAR OCCLUSION AND THEIR CLINICAL SIGNIFICANCE*

W. H. SWEET, M.D., AND H. S. BENNETT, M.D.

Department of Surgery, Massachusetts General Hospital, and Harvard University Medical School, Boston, Massachusetts

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The surgical treatment of intracranial aneurysms has been advanced in the past 15 years by several distinguished studies, amongst which may be mentioned (1) the description of cerebral angiography by Moniz; (2) the proof that elective ligation of the carotid artery in the neck is relatively safe in cases of aneurysm, by the collective work of British neurological surgeons and by the work of Dandy and Matas; (3) the reporting of several series of daring intracranial operations by Dandy, Dott, Jefferson, and others.

However, there remain a number of uncertainties related to the problem, particularly with respect to the long-term prognosis, the best type of operation, and the effectiveness of proximal ligation in reducing pressure in a weakened portion of the wall of an intracranial artery.

Available data are particularly meager with respect to the long-term prognosis, especially in those cases that have been characterized by one or more episodes of bleeding before completion of recovery from a previous subarachnoid hemorrhage. A patient with no localizing symptoms or signs following the first burst of subarachnoid bleeding is not commonly considered a candidate for angiography because of the alleged good prognosis. However, if a second outflow of blood occurs in the next few days or weeks, it is generally felt that the prognosis worsens a good deal, although we lack any good statistical study of the mortality in such cases. Gamsu is now following up the cases of subarachnoid hemorrhage in a group of Boston hospitals with the intent of making such a study upon which a prognosis might be based.

Further uncertainty prevails when an angiogram has demonstrated the precise location of an aneurysm on the internal carotid or one of its branches and a decision must be made as to whether the case requires no operation, ligation of one of the carotid arteries in the neck, or an intracranial approach to the aneurysm. Dandy, in his last work, regarded only a direct approach to the aneurysm itself as surgical treatment, and saw fit to carry out such direct operations on 8 infraclinoid and 13 supraclinoid aneurysms of the internal carotid and on 4 aneurysms of the anterior cerebral vessels. He classified ligations of the internal carotid artery in the neck as a “preoperative procedure.” Dandy’s results may be summarized by

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stating that 7 of his 8 patients with intraclinoid aneurysms survived a direct clamping or a trapping of the aneurysm between intracranial and cervical closures of the internal carotid, whereas the results of similar treatment of supraclinoid aneurysms were less encouraging. In 3 of 12 cases of the latter type in which the operation was not an emergency, the patients died from the operation; 1 of the survivors had a permanent hemiplegia and aphasia, and in 8 the aneurysm was effectively treated without producing disabling sequelae. In 3 of the successes a massive hemorrhage occurred from the internal carotid during operation and required emergency occlusion of that vessel, which happily was well tolerated. Although these brilliant operations represent a major contribution, the difficulty of the procedure and the discouraging ratio of 4 disasters to 8 cures make advisable a consideration of the effectiveness of simpler and less dangerous measures, such as the ligation of the internal or common carotid arteries in the neck.

Accordingly, the measurements reported in this paper were designed to shed light on the uncertainties related to the effectiveness of carotid ligation in reducing the hydraulic pressure in an intracranial aneurysm. We have carried out direct measurements of intra-arterial pressure in the internal carotid artery before and after closure of various vessels in the neck pertinent to the problem. The principal objective of these measurements was to determine whether or not a major fall in blood pressure in the distal portion of the internal carotid artery was obtained consistently by occlusion of that vessel in the neck. From the data obtained we have deduced whether or not the pressure on a weak intracranial aneurysmal wall might be significantly reduced.

Direct measurement of intra-arterial pressure changes in the region of the circle of Willis would have been preferable, but we were unable to pass a catheter suitable for pressure measurements past the tortuosities of the intrapetrous and intracavernous portions of the internal carotid artery. Accordingly, we reluctantly contented ourselves with the methods described below.

**MATERIALS AND METHODS**

Measurements were taken on 13 patients ranging in age from 5 months to 65 years. The common, internal and external carotid arteries were exposed to direct vision under procaine anesthesia in the cases of the 11 adults, and under general anesthesia in the cases of the 2 children.

The pressure-recording system was connected to the lumen of the internal carotid artery by means of a $\#16$ or $\#18$ gauge needle whose point was inserted into the common carotid artery and then passed on up into the internal carotid artery. The hydraulic pressure was transmitted from the needle by flexible non-distensible Saran tubing filled with fluid to a glass membrane optically recording manometer equipped with a hydraulic integrator bypass system. The apparatus has been fully described by Bennett, Bassett, and Beecher. This recording system permitted one to record faithfully and continuously at will either a full pulse pressure or an integrated mean pressure, with ready and speedy conversion from either form of recording to the other. The needle was frequently irrigated with normal saline solution containing heparin in order to preclude the formation of any thrombi. Needles with stilets were used, and following the pressure studies the stilet was inserted into the needle and the patient