FUNCTIONAL TRIFURCATION OF THE INTERNAL CAROTID ARTERY AND ITS POTENTIAL CLINICAL SIGNIFICANCE*

HOMER D. KIRGIS, M.D., RAEBURN C. LLEWELLYN, M.D., AND EDWARD McC. PEEBLES, Ph.D.

Departments of Surgery and Anatomy, Tulane University School of Medicine, and Section on Neurosurgery, Ochsner Clinic, New Orleans, Louisiana

(Received for publication November 13, 1959)

Some individuals tolerate complete occlusion of the internal carotid artery without experiencing symptoms suggesting focal cerebral ischemia or demonstrating neurologic deficits indicating it. Others may experience a series of minor strokes, and then become asymptomatic. Still others, however, after a series of minor strokes, suddenly have a major stroke from which they may or may not make a satisfactory recovery. A small percentage of such patients will, without prodromal symptoms, suddenly have a major stroke from which they never recover to a significant degree. Although young patients, in general, tolerate interruption of the blood flow through an internal carotid artery better than older patients, widely divergent reactions may occur in patients of apparently comparable cardiovascular status. Actually, the situation may appear paradoxical in that a severe, persistent neurologic deficit with obstruction of the internal carotid artery may develop in a relatively young patient whereas a much older patient may tolerate such obstruction quite well.

Undoubtedly, many factors influence a patient's tolerance to obstruction of the internal carotid artery. These include the peripheral blood picture, the blood pressure, the degree of peripheral atheromatosis, the tendency to development of vasospasm, the extent of anastomotic relations between the internal and external carotid arterial systems, the rapidity of occlusion of the artery, and the anatomic pattern of the circle of Willis. Certain chain reactions have been postulated as a common cause of focal cerebral ischemia. For example, if a patient becomes grossly hemiplegic in the presence of partial obstruction of the internal carotid artery by an atheromatous plaque, it may be suggested that embolization of material from the plaque or of a thrombus about the plaque has occurred. This may be postulated to have caused obstruction of the middle cerebral artery and thus have caused the cerebral tissue in its area of distribution to be dependent completely upon collateral flow through the relatively small pial and intracerebral anastomototic vessels with resulting ischemic infarction. It has been theorized that this initial reaction might also produce changes that would cause extensive extravasation of blood into the tissues of the cerebrum. However,

* Presented at the meeting of the Harvey Cushing Society, New Orleans, Louisiana, April 30, 1959.
TRIFURCATION OF INTERNAL CAROTID ARTERY

angiography and examination of the intracranial vessels at autopsy indicate that actual obstruction of the cerebral vessels is relatively uncommon.

Correlation of the data available from the variable clinical pictures presented by interference with the blood flow through an internal carotid artery with reported data obtained by actual examination of the cerebral vessels would cause one to suspect that a cerebral hemisphere may be unusually dependent congenitally upon its carotid circulation. Although several of the systems of arteriolar anastomoses for collateral blood flow to the cerebrum, such as those of the pial plexus and those within the substance of the brain, are extremely important, they undoubtedly are consistent in their development and probably do not often contribute significantly to the extreme variations in clinical response to occlusion of the internal carotid artery. However, the circle of Willis constitutes a strategically located series of vascular anastomoses which demonstrates congenital variations that may be of considerable significance with regard to the degree to which a cerebral hemisphere will tolerate interference with its carotid blood flow.

In current textbooks of anatomy the circle of Willis in the adult is illustrated as being symmetrical and so proportioned that the anterior and middle cerebral arteries represent the bifurcation of the carotid artery (Fig. 1). The anterior and posterior communicating arteries are illustrated as

Fig. 1. Photograph of inferior surface of arteries at base of brain showing essentially normal adult anatomic pattern of circle of Willis.