THE ROLE OF COMPLETE CEREBRAL ANGIOGRAPHY IN NEUROSURGERY*

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The importance of establishing an exact topographic and pathologic diagnosis of an intracranial lesion cannot be overemphasized. Angiography, a valuable diagnostic procedure which at first met with opposition, is now generally acceptable and needs no further introduction. All intracranial lesions have some degree of influence on the vascular system; however, the effect is not necessarily restricted to the arteries alone; the arterioles, capillaries, and veins are often affected.

The average speed of blood flow from the common carotid artery in the neck to the internal jugular vein in the neck is 4 1/2 seconds. This figure has been repeatedly computed by both chemical and roentgenographic methods.1,5,26 Thus, a serial roentgenographic record of the movement of radiopaque material in the cerebral vessels during this interval of time offers an excellent opportunity for the study of vascular implications of various lesions.

Thorotrust and diodrast have been employed as contrast materials. Their advantages and disadvantages will not be discussed here, since they have been exhaustively explored by Northfield and Russell,3,19 Egström and Lindgren,6,7 Reeves and Stuck,21,24 Lowman and Doff,17 Martland,18 and Gross.10,11,12,13,14

METHOD

The open operation or the direct intra-arterial puncture is used, depending on the indication. The nature of the lesion of course dictates the indication. The entire procedure is done on the X-ray table under sterile surgical conditions. An automatic seriograph is used which is adaptable to all standard X-ray equipment. This innovation developed by one of us (S.-P.) eliminates the confusion caused by apparatus requiring manual cassette changing reported previously by Moniz,1,5 Sanchez-Perez,22 and others. It allows reloading of films without interference to the operators. Controlled exposures are made .75 of a second apart by an automatic motor-driven cassette changer. Eight cc. of material are injected in a single burst through a 17 gauge needle.

Serial filming process is started just before the end of the injection.

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Ordinary experience gives good timing. Six roentgenograms are taken within 4½ seconds at regulated time intervals. These films serially demonstrate the cerebral blood flow and constitute a reasonably complete angiographic record of the average patient. Film No. 1 usually shows the common carotid artery, the internal and external carotid artery, and the carotid siphon. Film No. 2 demonstrates the cerebral arterial system. Film No. 3 as a rule shows nothing but a diffuse opacity (this is the capillary phase), often important in neoplastic lesions. Film No. 4 is an intermediary stage and shows the ascending and descending veins. Film No. 5 demonstrates the venous elements emptying into the sinuses. Film No. 6 shows no dye in the cranial cavity in the average normal patient. In the event of pathologic conditions which prolong circulation time to an unusual degree, a second—third—ad finitum, series of films can be made. The second series would start 4-5 seconds after injection, etc., until the complete circulation time of the injected area is known. The instrument here reported is, therefore, not limited as far as time is concerned.

MATERIAL

Seven selected patients on whom angiographic studies were made have been chosen for report. They represent examples of lesions which differ considerably in their effects on cerebral circulation. The speed of blood flow in these patients has varied remarkably; it was either above or below normal depending on the nature of the lesion.

In the average patient with a vascular obstructive lesion, roentgenogram No. 6 will usually show the venous phase which indicates a slowing down of the blood flow. Conversely, in other patients with cerebrovascular short-circuit lesions, the opaque material leaves the cranial cavity more rapidly than in the normal case. It therefore becomes apparent that complete cerebral angiography can demonstrate not only topographic but pathologic data of increasing significance.

Arteriovenous communications, which have been described repeatedly, were recently reviewed by List and illustrated by angiography. Such lesions are mainly of two types: (1) congenital vascular malformations and (2) arteriovenous aneurysms or fistulas of traumatic etiology. These arteriovenous lesions have been reported by Shenkin et al. as factors that increase the rate of blood flow in the cerebral circulation. When the circulation time in the presence of such lesions is explored by chemical means, misleading conclusions are possible.

Certainly, the chemicals in the blood pass through the cranial cavity with greater speed because the way itself is shorter due to the short-circuited system. We believe, however, that under such circumstances the actual cerebral circulation time may be prolonged. It is true that a short-cut in the circulatory system allows the blood to leave the brain sooner, generally in 2½ seconds. The fact remains that the complete angiogram often shows no evidence whatever of opaque material entering the general cerebral circulation. On the contrary, the material usually remains confined to the short circuit.