INTRACRANIAL ANGIOGRAPHY
I. THE DIAGNOSIS OF VASCULAR LESIONS

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THE SYMPTOMS and signs of vascular lesions within the cranium are not always sufficiently typical to permit accurate diagnosis on the basis of clinical findings alone. Even such aids as spinal fluid examination, roentgenography of the skull and pneumoencephalography may fail to tell the exact story. We now possess in the procedure of cerebral angiography a precise method to demonstrate intracranial blood vessels roentgenographically. Angiography may not only show the site of the suspected vascular lesion but it often reveals its anatomic character as well.

In spite of its accuracy, cerebral angiography should not be indiscriminately employed in suspected vascular lesions of the brain. Firstly, the method requires a painstaking and relatively complicated technique which has been described elsewhere in detail (Moniz, List, Burge and Hodges). Secondly, it must be remembered that concentrated radiopaque material is introduced into a diseased vascular system. Injection of foreign substances under pressure has the potential hazard of increasing vascular damage by producing spasm, thrombosis or even rupture of the vessel, yet, as a rule, no such ill effects need to be feared if proper technique and indications are used. Thorotrast has proven in our hands the most satisfactory contrast medium available and has been used by us without incident, even though it admittedly does not meet ideal specifications. Cerebral angiography should be performed according to the following directives. (1) It is indicated especially whenever surgical treatment is under consideration and a precise diagnosis is required for such therapy. Conversely, the procedure is usually inadvisable when the differential diagnosis is merely of academic value. (2) Angiography is contraindicated in very old patients and those with far advanced arteriosclerosis, hypertension, cardiac decompensation or recent embolic or thrombotic episodes. It is likewise contraindicated in most cases of acute intracranial hemorrhage, yet it is permissible in the exceptional instances in which conservative management carries greater risk than surgical treatment.

Admittedly, angiography has certain technical and diagnostic limitations. It is not possible to inject the entire intracranial vascular system by one single procedure. If both hemispheres are to be studied, bilateral injection is required; carotid or vertebral injection must be used to demonstrate the respective arborizations of these vessels.
Intracranial angiography has been used extensively in the University of Michigan Hospital since 1941. The technique has been previously described in detail\(^9\) and will be briefly reviewed.

**Carotid Arteriography.** Under local anesthesia the carotid bifurcation is exposed by means of an incision anterior and parallel to the sternocleidomastoid muscle. Segments of the common, internal, and external carotid arteries are dissected free. A rubber strip (split Penrose drain) is placed around the common carotid and another around the beginning of the external carotid. The patient is then transferred to the x-ray table and his head turned to the non-operated side (for the lateral projection). Injection equipment consists of three 10 cc. and three 20 cc. Luer syringes, an 18 or 19 gauge needle of medium bevel, 3–4 cm. in length, and a 10 cm. length of pliable, though non-collapsible rubber tubing fitted on either end with adaptors. This equipment must be tested in advance. The common carotid is elevated without strangulating the vessel, by means of the rubber strip, and the external carotid is pulled upward slightly and purposely strangulated by twisting its rubber strip. After the needle-tube-10cc. syringe combination has been filled with contrast medium, a puncture is made into either the beginning of the internal carotid or the common carotid artery close to the bifurcation. Multiple punctures should be avoided. When the needle is in proper position, the intrarterial pressure will push back the plunger of the syringe and the needle will be gripped by the elastic arterial wall. Ordinarily three injections are made, two to obtain a stereoscopic pair of arteriograms and venograms in lateral projection and a third for a single arteriogram in anteroposterior projection. Thus a total of five films is exposed. Thorotrast (sterile thorium dioxide in 25 per cent colloidal suspension) is used as contrast medium, each injection consisting of 10 cc. of thorotrast (8–12 cc. may be used). The contrast medium is injected as rapidly as possible and, when the injection is two-thirds complete, the signal for x-ray exposure is given to obtain the arteriogram. Three seconds after the completion of the injection a second exposure is made to record the venogram. Without disturbing needle and tubing, the empty 10 cc. syringe is replaced by a 20 cc. syringe containing Ringer's solution, and rubber tubing and needle flushed to prevent clotting. In the meantime, the x-ray tube has been shifted for stereoscopy. A second injection is then performed in an identical manner. Following the second injection, tubing and needle are again flushed with Ringer's solution, until the head is rotated to the anteroposterior position. The x-ray tube is so angled that its beam will pass through a plane that includes the external auditory meati and a point in the frontal midline, 5 cm. above the glabella. Since this injection requires longer exposure time the signal for x-ray exposure is given immediately after beginning the (third) injection. The strangulation of the external carotid is then released, the needle withdrawn and hemostasis accomplished by firm packing and digital pressure. When all bleeding from the puncture wound has stopped, packs and rubber strips are removed, and the wound is washed with warm Ringer's solution and closed in layers. A pressure bandage (small sandbag) is advisable to prevent after-bleeding.

**Vertebral Arteriography.** This is most easily performed by retrograde injection of the subclavian artery. The vessel is exposed by transverse supracleavicular incision and section of the anterior scalenus muscle. After occlusion of the peripheral part of the subclavian artery and of the thyreocervical axis, 10–15 cc. of thorotrast are injected into the subclavian artery against the direction of blood flow. X-ray exposure is made at termination of the injection. This method is not absolutely reliable and partial escape of contrast medium into the carotid system may occur.

**X-ray Equipment.** This consists of a regular stationary skull machine with a line focus, shock-proof tube (focal point 2.3 mm.), energized by a fully rectified transformer operating through a flat radial type of moving Potter-Bucky diaphragm at a target film distance of 90 cm. For lateral projection, an exposure time of 1.5 seconds is used at 20 MA and 75 KV; for anteroposterior projection, exposure time is increased to 3 seconds and kilovoltage to 85.