has permitted the modern neurosurgical attack on carotid and cerebral vascular lesions.  

The initial report by Egas Moniz, which was presented to the Société de Neurologie in Paris on July 7, 1927, is reproduced below.

References

ARTERIAL ENCEPHALOGRAPHY, ITS IMPORTANCE IN THE LOCALIZATION OF CEREBRAL TUMORS*

By Egas Moniz

The Sicard test of intraspinal injections of Lipiodol has rendered important services in the localization of medullary compression. At the same time it has constituted a big step forward in semiology, for the principle of putting into relief the radiographic opacity of the Lipiodol introduced into the cavities of the body has overthrown neurology and has become a general method which has progressed daily.

Recently the pathology of the gall bladder has been clarified considerably by the method of Graham, Cole and Copher. They have founded their experiments upon the action of certain preparations of phthalein and their selective elimination by bile, which was demonstrated by Abel and Rowestre for the study of the functional capacity of the liver. Graham, Cole and Copher started their work in 1923. They sought a compound with a phenolphthalein base with a fairly high atomic weight, such as, for instance, bromine or iodine, which, eliminated by the biliary channels, would show up the bladder as opaque to x-rays. They selected intravenous sodium tetraiodophenolphthalein and demonstrated the possibility of obtaining good pictures of the bladder in the dog. The American authors recognized at the beginning that the substance used was fairly toxic and replaced it with sodium tetrabromophenolphthalein. With bromine and iodine they obtained the desired results, except that the radiographic effects of iodine were more clearly visible than those of bromine.

After prolonged experimentation the authors decided upon phenotetraiodophenolphthalein as the most-to-be-recommended product, if it is pure. The undesirable effects on the animals, in some cases fatal, which were observed at the beginning with sodium tetraiodophenolphthalein were caused by impurities of the products. This was why they preferred the brominated compounds, which are less toxic but had to be used in larger quantities.

Having discovered the substance, it was now

necessary to study the means of entry. The gastric route, the intestinal, either by the introduction of coated substances or by using an Einhorn duodenal tube, and the rectal route have been practically abandoned.

Graham, Cole and Copher preferred the intravenous route, as being the most practical and the simplest, but taking special precautions with the manner of introducing the substance.

Phenolphthalein generally is used in a dose of 4 grams per 35 cc. of recently distilled water. The intravenous injection is pushed in very slowly, because the fall in arterial pressure is troublesome with rapid injections.

The method of the American authors shows the advantages of using opaque substances in the study of cavities normally not shown up by x-rays.

We used another route in the hope of obtaining visualization of the brain through the opacity of its vessels, particularly the arteries. This is the direction taken by our work.

Ventriculography has already been carried out to define the position of cerebral tumors. We believed that if we succeeded in visualizing the cerebral arterial network, it would also be possible to localize tumors on the basis of the alterations shown in the contexture of the arterial framework.

Before summarizing our experiments and our results in animals and humans, we should glance at the ventriculographic data obtained, as being an element in the diagnosis of cerebral tumors.

We are indebted to Dandy for the method of radiographic visualization of the lateral ventricles. His first note is dated 1918. Since then, Dandy and his associates have published other works and British and German neurologists have taken up this direction to obtain the localization of cerebral tumors by the study of the differences in appearance of the normal ventricles and those in brains with neoplasms.

The most commonly used substance for obtaining radiographic contrast was air. Oxygen or CO₂ has also been injected. Dandy has used thorium, potassium iodide, collargol, Argyrol and bismuth substrate, but the results were poor. Sicard used rising Lipiodol, that is iodinated oil with a lower percentage of iodine than the descending Lipiodol. Jacobaeus and Schuster also used Lipiodol. But air still remains the preferred substance. Resorption varies from a few hours to a few weeks. It is introduced into the ventricles either directly, or in cisternal or lumbar injections (Purves Stewart).

Most authors prefer direct puncture. This is performed by means of a cranial trepanation, either, for the anterior horn, 2 cm. from the median line, somewhat forward from the frontoparietal suture, or for the posterior horn at a point situated 3 cm. behind and 3 cm. above the external auditory orifice (Kocher). Other authors have given different points (Grant, Sicard, etc.).

In general 5 to 10 cc. of cerebrospinal fluid is drawn from the ventricle, and an equal quantity of air is injected, after which we wait for 2 to 3 minutes. Pressure becomes roughly equal to atmospheric pressure. Next we inject 90 to 120 cc. of air.

However, the methods are fairly variable (Dandy, Bingel, etc.). The radiographs are made with a Potter-Bucky diaphragm.

Ventriculography has often provided valuable information for the localization of tumors; but there are radiographs that show a deformation of the ventricles and it is still rather difficult to define the precise point at which the neoplasm is situated.

Recently, A. Elsberg and S. Sittler have made studies on cadavers of subjects who died of cerebral tumors, and upon making comparisons between ventriculographs and moulages they arrived at the following conclusions:

1. In the case of a tumor of the right posterior fossa, one sees a displacement outside the posterior horn of the right ventricle, with a reduction in the capacity of the right ventricle.

2. In the case of a tumor of the frontal and right temporal lobes, radiography shows a considerable lengthening of the distance between the anterior and posterior horns on the side of the tumor, while on the opposite side they come closer to one another. In the case of an occipital tumor there is a distention of the two horns showing roughly the same appearance.

In his book Jüngling has shown a series of figures with fairly informative diagnosis. But interpretation often remains extremely difficult, and, at least in a large number of cases, does not provide an indisputable localization.

In a discussion of the Section of Neurology of the Royal Society of Medicine⁴ the question was presented by Sargent, who considered that ventriculography was a clinical aid in the diagnosis of tumors. But he warned against the method being used more than in doubtful cases or cases impossible to diagnose by neurological means. Two questions arise in connection with ventriculography: the danger of air injection and

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2 Arch. of Neur. and Psych., October 1925.
