ISOTOPE TRANSFER TEST FOR DIAGNOSIS OF VENTRICULOSUBARACHNOIDAL BLOCK

ROBERT L. BELL, M.D.

Department of Neurosurgery, State University of New York, College of Medicine at New York City, and Neurosurgical Service, Kings County Hospital, Brooklyn, New York

(Received for publication March 25, 1937)

Since the time of Vesalius the term hydrocephalus has been used to designate the excessive accumulation of cerebrospinal fluid in the cranium without reference to the causative factor producing the pathological process. Interestingly enough such a designation is still in vogue, particularly in reference to children. Dorothy Russell has stated the overall problem quite clearly: "... the immense variety of pathological lesions productive of hydrocephalus have this single feature in common: all create an obstruction at some point in the pathway of the cerebro-spinal fluid." The classification proposed by her is based on an extensive review of necropsy material and conforms completely with our experience. The responsible pathological factor or factors for ventricular hydrops fall in four categories: malformations of the cerebrospinal axis, secondary to inflammatory diseases, a sequel to cerebral trauma, and in association with tumors. The anatomical locations of the lesions blocking the pathways of the cerebrospinal fluid are: lesions within the lateral ventricles, at the foramina of Monro, within the 3rd ventricle and iter, within or encroaching upon the 4th ventricle or the foramina of Luschka, in the subarachnoid space at the level of the incisura tentorii, partial obliteration of the subarachnoid space of the cerebral hemispheres, and obstruction of the dural venous sinuses. Diagnostic efforts should therefore be directed at a determination of the site of obstruction of the cerebrospinal fluid. Correlation of this with the other clinical features has been helpful in arriving at a logical diagnosis.

Among the supplementary diagnostic procedures that have been employed may be mentioned the phenolsulphonphthalein test of Dandy and Blackfan (reviewed recently by Bering), pneumoencephalography and ventriculography, intraventricular injection of radio-opaque contrast media, modification of Dandy's encephalography and ventriculography, and vertebral angiography. In some instances these procedures, singly or in combination, have established the site of obstruction of the cerebrospinal fluid and the pathological process responsible for the hydrops. Far too frequently after the gamut of diagnostic procedures has been exhausted a precise diagnosis remains obscure. Such circumstances lend stimulus for continued search for a better method of determining the site of block.

During an investigation of the rate of exchange of radioactive human serum albumin across the subarachnoid-vascular barrier in cases of "hydro-
ISOTOPE TRANSFER TEST FOR BLOCK OF CSF PATHWAYS

cephalus,” it soon became apparent that a nontoxic substance was available which might be useful in the determination of the site of block in the cerebrospinal fluid pathways. Thus a method was found which involved: a simple cerebral ventricular puncture without appreciable alteration of the ventriculosubarachnoidal hydrodynamics, the introduction of a chemically inert radioactive substance, and the identification of the position of this tracer substance by means of an external Geiger-Müller counter. Here then was a method for the study of obstruction to flow within the spaces containing cerebrospinal fluid without side effects. Moreover the procedure offered a means of determining patency of tubes used in ventriculoperitoneal shunts.

METHOD

In the present study, radio-iodinated (I\(^{131}\)) human serum albumin (RISA) was introduced into the ventricular system either by puncture of a lateral ventricle through an open fontanelle or a previously made cranial burr hole. The dosage employed was 100 \(\mu\)c. Immediately following injection the patient was placed in the erect position. The detector used was a shielded Anton G-M eye probe. The total counts per minute were obtained along the cerebrospinal axis. The total counts per minute were then plotted versus the inverse square of the distance from the point of injection (I/D\(^2\)).

PHYSICAL CONSIDERATIONS

As is well known, the intensity of radiation from a point source is inversely proportional to the square of the distance at which it is measured. This inverse square law of radiation physics is applicable in cases of obstruction in which the source of activity is limited to the ventricular system. If free communication exists between the ventricular system and the spinal subarachnoid space, other factors contribute to the intensity of radiation along the cerebrospinal axis. In addition to being a function of the law, the intensity of radiation is directly proportional to the cross-sectional area of the spinal subarachnoid space under observation, the rate of diffusion of the tracer material, and possibly the effect of the pumping action of the choroid plexus. Therefore in examples in which there is a block between the ventricles and the spinal subarachnoid space, a straight line is obtained when the total counts per minute are plotted against the reciprocal of the square of the distance. If free communication exists in the ventriculosubarachnoidal system, a curve plotted in the same fashion represents a complex function.

RESULTS

Twenty-five unselected patients with clinical evidence of hydrocephalus were submitted to this isotope transfer test. The following 3 case histories are illustrative.

Case 5. KCH #54525. W.J., a 10-month-old male, was admitted to the hospital because of progressive enlargement of the head of 8 months' duration. The circumference at the occipitobregmatic level was 66 cm. The chest measured 45 cm. One