THE USE OF PHENOLSULPHONPHTHALEIN IN THE CLINICAL EVALUATION OF HYDROCEPHALUS*

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The use of phenolsulphonphthalein to study the cerebrospinal fluid system was introduced by Dandy and Blackfan in 1913. They assumed this dye labeled cerebrospinal fluid as a whole and that it could be used as a measure of the absorption rate of cerebrospinal fluid as well as communication between the ventricles and the spinal subarachnoid space. However, new information about the cerebrospinal fluid which has been obtained through the use of radio-active and stable isotope tracers has made it necessary to re-examine the basic principles involved in this test to determine whether or not the interpretations usually placed on it are valid. This paper is a study of this test based upon some 301 dye studies done on various patients of the neurosurgical service of The Children’s Medical Center, Boston.

MATERIALS AND METHODS

The dye studies considered here have been carried out on neurosurgical patients (mostly under 2 years of age) as a part of their clinical investigation. The test has been done in very nearly the manner described originally, except that absorption of dye was studied only after ventricular injection.

Bilateral ventricular taps were done after investigation of the subdural spaces; simultaneously a lumbar puncture was done. The cerebrospinal fluid pressure of both the lumbar and ventricular regions was measured and samples of fluid were taken for study. Then 1 cc. of a neutral solution containing 6 mg. of phenolsulphonphthalein was placed into one lateral cerebral ventricle. The cerebrospinal fluid was allowed to drip from the lumbar needle for 30 to 60 minutes onto a gauze which had been soaked in ammonia. The time elapsed between injection of the dye and its appearance in the lumbar fluid was taken as the “communication time.” Dye was usually allowed to drip for some short period after this to see if the dye became more concentrated. In some cases in which no dye appeared in the 30- to 60-minute period repeated lumbar punctures were carried out at intervals of 1 or more hours for a 24-hour period. After all of the needles were removed, the urine was collected for a period of 24 hours with specimens being taken separately at intervals of 2, 3, 6, 8, 12 and 24 hours. The number of specimens from any

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one patient depended upon the urinary output, which was enhanced by forcing fluids orally and occasionally giving them parenterally. The amount of phenolsulphonphthalein excreted during each interval was calculated as a percentage of the total amount given. In a small group of patients the disappearance of the dye from the cerebral ventricles was followed as well as the excretion of the dye in the urine. This technique allows a measure of the volume of cerebrospinal fluid by measuring the dilution of the dye.

The time required for half of a tracer (in this case, phenolsulphonphthalein) to be removed can be used as a measure of its turnover or exchange rate. This time, known as the “half time,” will be used in the discussion of the data being considered here.

RESULTS

Communication of the Ventrices with the Subarachnoid Space. In 130 of the 301 patients tested, communication of the ventricles with the lumbar subarachnoid space was demonstrated by dye. The time of communication was recorded in 123 cases, and in 7 communication was found but the time was not recorded. These times were fairly well grouped and have been examined by standard statistical methods. The range of communication time was 0.3 minute to about 24 hours. The communication times over 1 hour are not strictly comparable as they were determined by multiple puncture and not steady flow. The mean time for dye to appear in the lumbar subarachnoid space after injection into the cerebral ventricles was 6.7 minutes with a 0.3 standard deviation from the mean of 4–6 minutes. This suggests that in any child who shows no communication within 20 minutes (mean plus 3 standard deviation) there is probably inadequate communication or the flow of cerebrospinal fluid is obstructed, and any patient who does not show signs of communication within 15 minutes should be regarded with great suspicion. It should be pointed out here that very often when doing this test the spinal fluid will stop flowing after a few minutes even though the needle is still in the subarachnoid space. This has been found to be a true indication of noncommunication between the ventricles and lumbar subarachnoid space.

There were 14 patients in this group in whom communication of the ventricles with the spinal subarachnoid space could not be confirmed by air ventriculography or who were thought to have obstructive hydrocephalus on other clinical grounds. In 5 of these patients, dye was not found in the lumbar cerebrospinal fluid for several hours, and this would be considered as evidence of noncommunication by the time limits given here. Three of these patients had obstruction of the foramina of Magendie and Luschka, 1 had an aqueductal atresia proven at operation, and in 1 no surgery was carried out. Four of the other 9 patients with relatively shorter communication times were found to have obstruction of the foramina of Magendie and Luschka which was seen in the air studies. The passage of dye in these patients was slow (over 10 minutes in all but 1) and the dye never reached a