Evaluation of Photoscanning of the Diffusion of Intrathecal RISA in Infantile and Childhood Hydrocephalus

DAVID C. MCCULLOUGH, M.D., AND ALFRED J. LUESSENHOP, M.D.
Division of Neurological Surgery, Georgetown University Hospital, and Department of Neurology and Neurosurgery, Children's Hospital of the District of Columbia, Washington, D.C.

The limitations of pneumography for delineation of available extraventricular subarachnoid space have encouraged us to examine the use of radioactive isotopes. The rate of diffusion and distribution of an isotope confined to this space could permit, by external scanning, an estimation of cerebrospinal fluid (CSF) distribution and dynamics. In contrast to pneumography, the procedure would not simultaneously disturb the CSF dynamics, and information so derived might be useful for assessing the severity and progress of hydrocephalus.

The physiological basis rests upon the observations of Sweet and others,\(^5,^6\) namely, that labeled protein is confined to the CSF space and, by diffusion and directional flow, passes over the hemispheres ultimately into the venous system along the major sinuses. The first clinical applications were for demonstration of spinal blocks.\(^5,^6\) Later, DiChiro, with others,\(^4,^5\) developed methods for demonstrating CSF fistulas, arachnoid cysts, porencephaly, and hydrocephalus, and introduced the term "isotope cisternography," which has been generally adopted. Currently the technique is being tried in studies of communicating hydrocephalus in adults.\(^1,^2\)

Our investigations were to assess the possible diagnostic usefulness in childhood and infantile hydrocephalus by correlating the isotopic findings with the degree and progression of the hydrocephalus as determined by previous pneumography, ventriculography, and clinical parameters. Some of the children were studied before and following insertion of ventriculoatrial shunts. Our experience so far includes 51 scans in 45 patients. The majority of these patients had hydrocephalus (28 infants and children, 12 adults) but we also included cases of pseudotumor cerebi, CSF rhinorrhea, and adult cerebral atrophy.

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Methods

The instrument for scintillation scanning was the Nuclear Chicago Pho-gamma III which produces a Polaroid print for each scanning interval in about 3 minutes and is thus well suited for use in infancy. Scans may be repeated at frequent intervals without necessitating a single prolonged period of full cooperation. However, most of the infants required some sedation with a Demerol-phenerganthorazine mixture in appropriate doses.

Saturated solution of potassium iodide (2 to 3 drops per day for 5 days) was administered to block thyroid uptake. Fresh, undiluted, high-specific-activity radiolabeled serum albumin (RISA) containing 500 microcuries (\(\mu\)c) per milliliter was injected, by barbotage, into the lumbar CSF. Doses of 2 to 5 \(\mu\)c per kilogram in volume of .05 to 0.5 cc were used. The spine and calvarium were scanned initially at 10 to 30 min intervals and thereafter at 1- to 4-hour intervals in both anteroposterior and lateral projections over 24 to 36 hours. Extrarachnoid injection, which occurred in three infants, became obvious within the first 30 min.

Results

All the infants and children were evaluated as to etiology and degree of hydrocephalus by ventriculography, pneumoencephalography, and clinical parameters including progress of head growth, measurement of intracranial pressure, psychomotor development, and relative ventriculoatrial shunt dependency.

Normal Control Studies. Two nonhydrocephalic infants were scanned as controls. The first was 2 months old and had undergone linear craniectomies for premature closure of the sagittal suture. Postoperative pneumography was normal, and he had not shown evidence of hydrocephalus after 10
patterns of isotope distribution in normal and mildly hydrocephalic infants (artist's sketch).

The other was 5 months old and convalescing from bilateral craniectomies for subdural hematomas. Here, too, the ventricles were of normal size, and there had been no evidence of postoperative increased pressure for 6 months.

RISA cisternography in both controls was uniform (Fig. 1). The isotope diffused cephalad from the site of injection, reaching the basal cisterns of the posterior fossa within 20 min. In 60 min the chiasmatic, ambient, and quadrageminal cisterns were visualized, and by 2 to 3 hours all the basal cisterns were completely demonstrated by the isotope. After 4 to 5 hours the activity in the cisterna magna began to recede, and there was a diffuse subarachnoid pattern over the hemispheres with concentration along the sagittal sinus. Thereafter the amount of activity gradually and uniformly decreased.

Low-Grade and Compensated Communicating Hydrocephalus. There were six patients in this category, ranging from 2 months to 12 years of age. Two were completely compensated, having had no increase in head size during the preceding 12 months. Their pressures, as measured by spinal puncture, were within normal range. The other four, also with mild ventricular enlargement, were continuing to show increase in head circumference but at a rate paralleling the curve of the 97th percentile. Isotope cisternography in these six showed no significant deviation of ultimate isotope distribution after 36 hours. Periods of follow-up have ranged from 1 to 2 years in these cases, and none has required a ventriculostomy.

Progressive Communicating Hydrocephalus. This category included four infants, 2, 4, 5, and 8 months of age. Meningitis was the probable etiology in three. They required frequent ventricular taps to control pressure prior to testing. In all four there was accumulation of the RISA in the lateral ventricles within 30 min. The ventricular activity became diffuse by 60 to 90 min and persisted in dense concentration at 24 hours (Fig. 2). Diffusion into the basal cisterns and over the hemispheres was sparse or absent.

This ventricular pattern was similar to that seen in nine adults with communicating hydrocephalus and normal CSF pressures, as measured in the lumbar space. In the adults, however, the appearance of the isotope within the ventricles was relatively delayed.

Communicating Hydrocephalus, Post-