Cisternal Brain Scanning with Positron Emitting Isotopes*

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Radioactive isotopes have been administered intrathecally and intraventricularly for many diagnostic purposes since the report in 1953 of the myelographic technique by Bauer and Yuhl. In 1957, Bell used a Geiger-Müller tube and intraventricular injections of radioiodinated albumin to plot the flow of fluid along the cerebrospinal axis, and to demonstrate the patency of ventriculoperitoneal shunts. In 1960, Benda and Brownell, and in 1961, Dupont, et al., scanned for tumors, aqueductal blocks, cerebrospinal fluid rhinorrhea, and spontaneous ventriculostomies and introduced for cerebrospinal fluid studies.

During the past 8 years, we have had experience with intrathecal injections of two positron-emitters, $^{74}$As and $^{68}$Ga. Our results are presented here to emphasize the value of cisternal scanning in children, the safety of $^{68}$Ga as a scanning agent and to note the unusual observations with $^{74}$As as compared with those described previously after intrathecal injections of other materials (gold, iodinated albumin, pertechnetate).

Materials and Method

Our supply of $^{74}$As sodium arsenate was obtained from Abbott Laboratories and later from the Radiochemical Centre, Amersham, England. It was administered intrathecally through a 20-gauge needle in the lumbar region with a dosage of 75 $\mu$C in infants and 750 $\mu$C in adults. The pH lay within the physiological range and was not adjusted. The $^{68}$Ga was eluted from a germanium-gallium generator which was procured from the New England Nuclear Corp., Boston, Mass. EDTA (ethylenediamine tetra-acetic acid) was neutralized and used at a strength of 0.005M to remove $^{68}$Ga from the generator. The pH of the gallium chelate was 9.8 and hence unsuitable for intrathecal injections. It was therefore adjusted to pH 7.0 with HCl. The final pH was checked carefully with a meter and not by paper as suggested by Yano and Anger.

The dosages of gallium were 500 $\mu$C for children and 2 $\mu$C for adults. Because of the very short half-life of 68 min, these gave low total body radiations of 15–50 milliRad.

All scans were carried out with the Sweet-Brownell positron scanner. The coincidence count (and not the unbalance) records were used. Poor definition of the cisterns was found with the use of the regular scanning heads because of the large aperture size (1 3/8 in. diameter). Accordingly, extra shielding in the form of lead inserts with apertures of ½ to 1 in. were used for all children and some adults. The usual scanning speed of the instrument was doubled so that each study was completed in 16 min. Alternate lateral and anteroposterior views were obtained.

A small vial containing 20–25% of the injected dose of $^{74}$As or 2.5% of that of $^{68}$Ga was scanned with the patient in order to quantitate the amount of isotope arriving intracranially.

Results

Radioarsenic. A significant amount of isotope rose quickly to the cisterns of the posterior fossa within the 16 min of the scan initiated immediately after injection. In infants, this was found without dilution or barbotage. On the later view, a triangular isotopic
deposit was found (Fig. 1A) and appeared to occupy the cerebellar and pontine cisterns. Within an hour the isotope passed cephalad to lie in the position of the interpeduncular, chiasmatic, and quadrigeminal cisterns at the base of the hemisphere (Fig. 1C). The material in the spine disappeared during the same time and could be readily picked up in the bladder. A known amount of isotope was scanned with the patient as a standard; it was found with this that 20 to 25% of the injected dose passed intracranially. Later scans showed that radioarsenic appeared to be fixed in the basal cisterns for long periods whose half-time was about 24 hours. This retention is shown in the 24-hour scan in Fig. 1D and also in Fig. 2. For comparison, scans obtained following the lumbar subarachnoid injection of iodinated albumin are shown in Fig. 3. These show a definite passage over the surfaces of the hemispheres and an accumulation as a cap-like deposit near the superior sagittal sinus after 24 hours. This pattern was not found on any of our arsenic scans.

The anteroposterior scans were useful in showing that the ventricular system was entered only in the presence of a functioning shunt for hydrocephalus and in a few other instances (as in low-pressure hydroce-