CISTERNOGRAPHY WITH CHELATED COMPLEX OF ^{99m}Tc

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The kinetics of chelate, inulin, and albumin have been demonstrated to be similar in the cerebrospinal fluid (*1*) which make each of these agents potentially useful in cisternography. Improved cisternograms have been obtained with albumin labeled with ^{99m}Tc (*2,3*). It is specially suitable for the study that can be completed within 24 hr. In prolonged studies, however, ^{131}I-albumin or ^{169}Yb-chelate are preferred (*4*). The low radiation dose from ^{99m}Tc is an advantage, but adequate precautions are necessary to have the quality of the radiopharmaceutical suitable for intrathecal injection. It is not easy to be assured of the sterility and the apyrogenicity of a ^{99m}Tc-albumin preparation prior to the administration. The potential toxicity of albumin has also been recognized, and substitution of inulin for albumin has been proposed (*5*). The chelate is not toxic if used in small amounts (*6*), and no reaction has been observed with ^{169}Yb-chelate when used in a large number of patients for cisternography (*7*). At present a simple method of labeling chelate (DTPA) with ^{99m}Tc is available (*8*) which can be modified for use in cisternography. Improved quality control of ^{99m}Tc-DTPA is possible compared with ^{99m}Tc-inulin or ^{99m}Tc-albumin.

MATERIALS AND METHODS

Kits were prepared in batches for use up to 2 weeks with $CaNa_3DTPA$ and trace of $SnCl_2$ under N_2 atmosphere using the basic method of Eckelman and Richards (*8*).

Approximately 25 mCi of $^{99m}TcO_4^-$, in a volume of 1 ml or less were added into the kit before the study. After a minute of gentle mixing, 10 ml of isotonic saline were added. One milliliter of the solution contained 2 mCi of ^{99m}Tc chelated in the presence of about 400 μg of the calcium salt of DTPA. Doses of 1 ml or less were used for cisternography in adult patients. Children received reduced doses.

Quality control tests were carried out with kits for each batch of preparation before use. Sterility and

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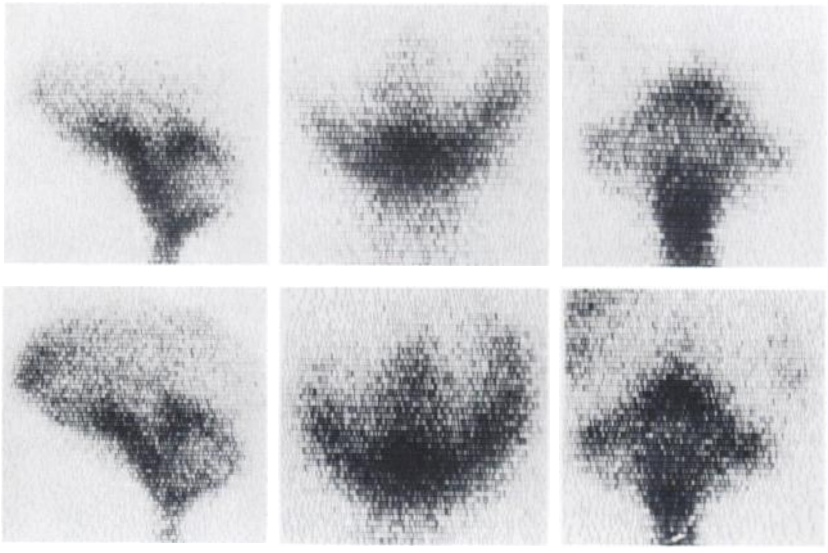

FIG. 1. Cisternograms, interpreted as normal, for adult patient who had aneurysm in anterior cerebral arteries (as observed with right brachial arteriography) and was referred for evaluation of probable hydrocephalus. Left to right: Lateral, anterior, posterior views. Top: 2-hr cisternograms. Bottom: 6-hr cisternograms.

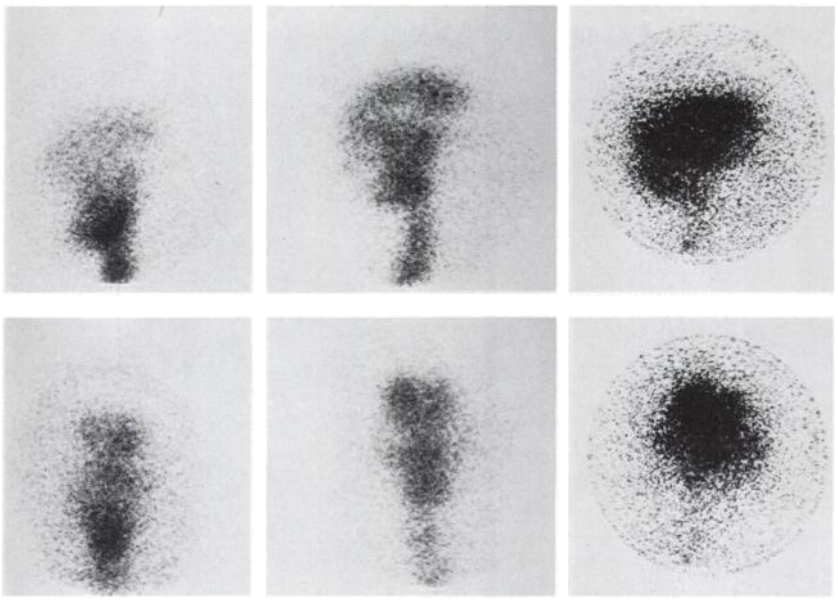

FIG. 2. Cisternographic study in 9-week-old baby. Lateral ventricles were visible until 24 hr; this was interpreted as communicating hydrocephalus with partial stasis. Left to right: 2-, 6-, and 24-hr cisternograms. Top: lateral views. Bottom: anterior views.

apyrogenicity tests were carried out with few kits as samples. Further, a sample preparation of ^{99m}Tc-DTPA in isotonic saline was tested for (A) renal clearance as a glomerular agent in a dog, (B) sterility, and (C) apyrogenicity.

RESULTS

We have used ^{99m}Tc-DTPA in clinical studies and found it suitable for cisternography. It is equally suitable for myelography and ventriculography. The results with respect to the quality of the scans and the diagnostic value of the studies were similar to those obtained with ^{99m}Tc-albumin or ^{169}Yb-DTPA up to 24 hr.

Figure 1 represents normal cisternograms of an adult patient obtained with a rectilinear scanner. Figure 2 shows a cisternographic study with a gamma camera in a baby in whom the radioactivity was observed in the lateral ventricles. Figure 3 shows a ventriculographic study with a gamma camera in a child to evaluate the patency of a surgical shunt.

DISCUSSION

With the ready availability of $^{99m}TcO_4^-$ and the simple method of chelation, ^{99m}Tc-DTPA can be used for a wide range of cisternographic studies. When prolonged studies are desirable, a relatively long-lived radioactive chelate should be used, such as those with ^{67}Ga, ^{111}In, and ^{169}Yb (*9*). The characteristics of ^{111}In appeared to be optimal (*10*). The quality control of ^{99m}Tc-DTPA preparation is not as perfect as that for ^{169}Yb-DTPA with its longer physical half-life of 32 days (*6*), but it is certainly superior to ^{99m}Tc-labeled inulin or albumin. Radiation dose with ^{99m}Tc in cisternography is relatively very low (*9*). If ^{99m}Tc is preferred for cisternography, we recommend its use in the form of chelated complex. It is safer and more convenient.

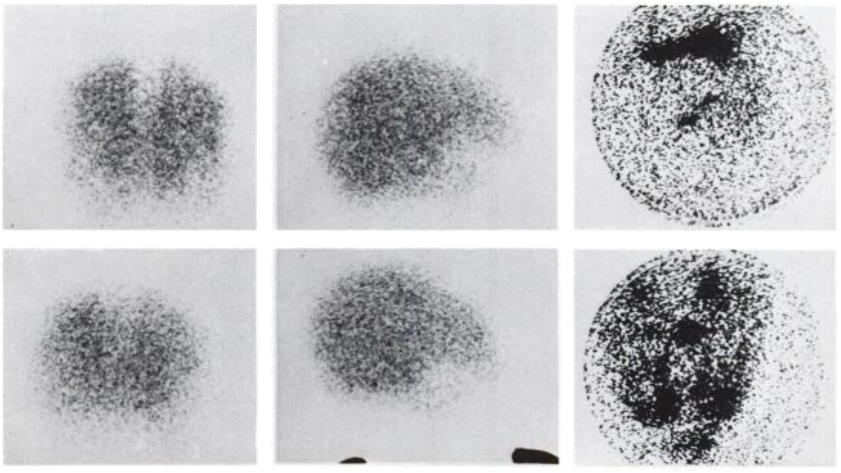

FIG. 3. Ventriculographic study for 5-year-old child who developed communicating hydrocephalus, and ventriculo-peritoneal shunt was established. Ventricles were markedly enlarged and study showed patency of shunt. Left to right: Anterior and lateral ventriculograms, abdominal radioactivity. Top: 10-min study. Bottom: 30-min study after pumping shunt.

The probability of chemical toxicity from the present preparation is extremely low. Toxicity results were similar to those reported earlier (*6*). It was further observed that $CaNa_3$-DTPA is less toxic than Na_5-DTPA. The total amount of the chelate in the tracer dose for a study can be further reduced by using a larger amount of ^{99m}Tc for chelation in the kit.

SUMMARY

Technetium-99m complexed with diethylenetriaminepentaacetic acid (^{99m}Tc-DTPA) has been used for cisternography and ventriculography. Although the behavior of chelate in cerebrospinal fluid is similar to that of albumin, ^{99m}Tc-DTPA offers better quality control and provides a simple method of preparation of the radiopharmaceutical. This agent is more safe with respect to potential toxicity than ^{99m}Tc-labeled inulin or albumin.

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