CISTERNOGRAPHIC IMAGING PATTERNS: EFFECTS OF PARTIAL EXTRA-ARACHNOID RADIOPHARMACEUTICAL INJECTION AND POSTINJECTION CSF LEAKAGE

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A cisternographic pattern of subarachnoid block with transient or no ventricular radiopharmaceutical reflux was observed in 52% of 105 patients with partial extra-arachnoid injections or postinjection leakage of CSF or both at the lumbar puncture site. In several patients, adequate repeat studies demonstrated considerably different CSF flow patterns. This block pattern was seen in only 11% of 217 patients with adequate intrathecal injections. Lumbar CSF leakage may alter the pattern seen on a cisternographic study and, if present, the study should be interpreted with caution.

Radionuclide cisternography is a reliable means of demonstrating cerebral spinal fluid (CSF) flow patterns and has been widely used in the evaluation of demented patients with suspected hydrocephalus (*1*). Various cisternographic patterns have been described and correlated with the clinical results of neurosurgical shunting (*1–5*). The cisternographic pattern most frequently associated with a favorable response to shunting has been that of communicating hydrocephalus in which one sees ventricular reflux and stasis with subarachnoid block (*2,3*). Patients with cerebral atrophy having either normal studies or only slow flow of the radiopharmaceutical to the parasagittal region generally do not respond to shunting (*6*). In some patients, intermediate patterns are seen including those with transient ventricular reflux with or without abnormal subarachnoid flow and those with evidence of subarachnoid block only (*1,3,7*). In the cisternographic evaluation of demented patients, we noted that the subarachnoid block pattern seemed to occur more frequently in patients with partial extra-arachnoid localization of the radiopharmaceutical. We have therefore reviewed the results of 322 consecutive cisternograms to investigate the significance of this intermediate pattern and to study its relationship to the presence of extra-arachnoid activity.

METHODS

Three-hundred-twenty-two consecutive cisternograms performed in 280 patients between January 1972 and May 1974 were reviewed. Thirty-four patients underwent cisternography two or more times either because of a previous inadequate injection or for followup evaluation of a previously demonstrated abnormality.

Cisternography was performed in the standard manner following the lumbar intrathecal administration of either ^{131}I-albumin (100–150 μCi) or ^{111}In-DTPA (250–500 μCi). Radiopharmaceutical injection was generally made with a 20-gage spinal needle; the patients were kept in the prone position after injection. Imaging was performed with a gamma camera. The patient's lumbar area was routinely imaged after injection to detect extra-arachnoid activity. Multiple images of the head were obtained approximately 4, 24, 48, and frequently 72 hr after injection. The images were evaluated for the presence and duration of ventricular reflux of the radiopharmaceutical and categorized in the following manner: no ventricular reflux; ventricular reflux persisting for less than 24 hr or for only 24 hr with subsequent clearance; or ventricular reflux lasting for 48 hr or longer. Convexity flow was classified as normal (parasagittal activity by 24 hr), slow (parasagittal region reached later than 24 hr), or block (parasagittal region never reached with no progression of tracer beyond the level of the block). Extra-

Received Aug. 19, 1974; revision accepted Nov. 10, 1974.

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arachnoid activity was considered to be present if the lumbar images demonstrated an abnormal pattern of inadequate injection (*8*) or renal or bladder activity and if the early head images demonstrated blood pool activity.

RESULTS

Of the 322 cisternograms reviewed, 105 (33%) demonstrated at least partial extra-arachnoid localization of the radiopharmaceutical. The cisternographic patterns seen in these 322 studies are shown in Table 1. Of the 105 studies with evidence of extra-arachnoid activity, 23 were uninterpretable since virtually no radiopharmaceutical was in the subarachnoid space (Fig. 1). In the remaining 82 cisternograms, sufficient tracer was present in the subarachnoid space to permit serial imaging to be performed. A pattern of subarachnoid block with either transient or no ventricular reflux was observed in 55 (52%) of the studies with extra-arachnoid activity. The block was most often at the level of the Sylvian fissures. In comparison, only 24 of 217 (11%) cisternograms with no extra-arachnoid activity demonstrated this pattern. Thirty-three of 217 (15%) studies with a good injection were interpreted as normal whereas only 5 of 105 (5%) studies with partially extra-arachnoid injections exhibited normal patterns. As can be seen from Table 1, the frequency of the other cisternographic patterns also differed considerably between the two groups.

TABLE 1. RELATION OF FREQUENCY OF CISTERNOGRAPHIC PATTERNS TO PRESENCE OF EXTRA-ARACHNOID ACTIVITY

Cisternographic pattern		Extra-arachnoid activity	
Ventricular activity	Subarachnoid flow	Absent	Present
Absent	Normal	33*	5
Absent	Slow	48*	10
Absent or ≤24 hr	Block	24†	55
≤24 hr	Slow	50†	3
>24 hr	Block	54†	4
Incomplete study		8	5
Uninterpretable study		0	23
Total		217	105

* Significantly different from extra-arachnoid activity group at $p < 0.01$.
† Significantly different from extra-arachnoid activity group at $p < 0.00001$.

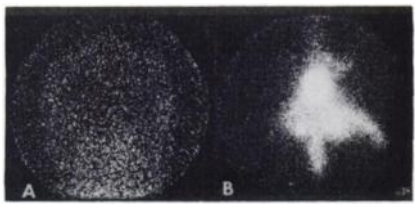

FIG. 1. Uninterpretable cisternographic study due to complete extra-arachnoid injection of ^{111}In-DTPA. Anterior image of head (A) demonstrates only blood pool and soft-tissue activity. Posterior image of lumbar injection site (B) shows radiopharmaceutical in mixed epidural and ligamentous distribution.

TABLE 2. REPEAT CISTERNOGRAM RESULTS FOLLOWING INITIAL INADEQUATE INJECTION

Initial study	Repeat study	No.
Uninterpretable	Uninterpretable	10
Uninterpretable	Successful	6
Partially extra-arachnoid	Partially extra-arachnoid: no significant change	2
Partially extra-arachnoid	Successful*	4

* Cisternogram pattern changed in three of four patients.

Thirteen studies were for evaluation of CSF otorrhea or rhinorrhea and no images beyond 6 hr were obtained. Consequently, these studies could not be classified according to flow patterns.

Of the 34 patients who underwent more than one cisternogram, 22 had repeat studies either because their initial study was uninterpretable or it had demonstrated evidence of extra-arachnoid activity. A comparison between the success of initial and repeat studies is shown in Table 2. Most of the initial cisternograms were uninterpretable and therefore provided no imaging patterns for comparison with the repeat studies. In four patients who initially showed partial extra-arachnoid activity, the second study demonstrated no extra-arachnoid activity. In three of these four patients the pattern on the repeat study (obtained 6–33 days later) was considerably different from that seen on the initial study. An example of this pattern change is shown in Figs. 2 and 3.

DISCUSSION

The reported frequency of inadequate cisternographic studies has ranged from 11 to 24% (*8–10*). Our failure rate of 33% is somewhat higher and may reflect our criteria for assessing an injection as inadequate. Only 23 of 322 cisternograms (7%) were considered uninterpretable, i.e., showing little or no radiopharmaceutical in the subarachnoid space. In those studies (82 of 105) with evidence of extra-arachnoid activity and in which the examination was carried to completion, the observed extra-arachnoid activity may reflect either actual partial extra-arachnoid injection or may represent subsequent leakage of CSF at the dural puncture site. The higher frequency of the block pattern in the patients with extra-

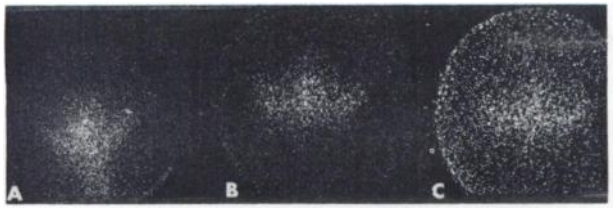

FIG. 2. Initial cisternographic study with ^{111}In-DTPA in 69-year-old man with dementia. Anterior images at 4 (A), 24 (B), and 48 (C) hr are shown. There is blood pool activity in addition to cisternal activity on 4-hr image as result of partial extra-arachnoid distribution and there is apparent block at level of Sylvian fissures.

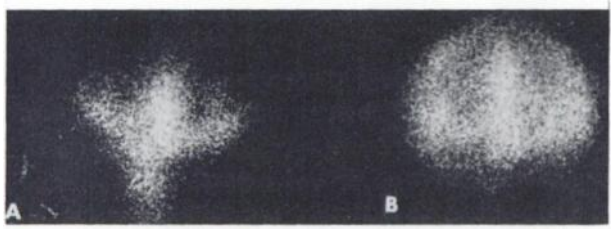

FIG. 3. Repeat ^{111}In-DTPA cisternogram obtained 1 month later on same patient as in Fig. 2. Anterior images at 4 (A) and 24 hr (B) are normal.

arachnoid activity may relate to leakage of CSF at the lumbar puncture site with an alteration in the usual CSF flow pattern over the convexities to the parasagittal region. An apparent block to flow might appear under these circumstances. An alternative hypothesis might be that these patients had an underlying abnormality of subarachnoid CSF flow that predisposed to leakage of CSF through the lumbar puncture site. The patients in whom repeat studies demonstrated a change in the cisternographic pattern, however, argue against this hypothesis.

To decrease the failure rate of cisternography, DiChiro (*11*) has suggested several modifications in injection procedure related to patient position, needle puncture technique, and injectate volume. He has pointed out that cisterna magna injection is an easy alternative route that is less likely to result in extra-arachnoid activity. An impressive decrease in failure rate has also been reported with hyperbaric cisternography (*12*). This technique presumably prevents leakage of the radiopharmaceutical at the arachnoid puncture site by increasing the rate of movement of the radiopharmaceutical towards the head.

Since the incidence of unsuccessful cisternographic injections seems to be associated with previous lumbar punctures, Benson, et al (*9*) have suggested waiting at least 7 days after a previous lumbar puncture to increase the likelihood of a successful injection. In a large series of cisternograms, however, Larson, et al (*8*) did not find previous lumbar puncture to be a significant determinant of injection adequacy.

A cisternogram with predominant extra-arachnoid activity will be uninterpretable and should be repeated. Our experience suggests that caution should be used in interpreting those studies with partial extra-arachnoid activity but in which serial images are still obtainable. Continued leakage of CSF and radiopharmaceutical at the puncture site will frequently result in a cisternographic pattern suggesting a block of the cerebral subarachnoid pathways. A repeat study in which there is no evidence of extra-arachnoid activity is necessary to confirm the apparent block and may demonstrate a significantly different cisternographic pattern.

ACKNOWLEDGMENTS

This project was supported in part by National Institutes of Health Training Grant GMO-1747.

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