ISOTOPE CISTERNOGRAPHY IN THE EVALUATION OF PATIENTS WITH SUBARACHNOID HEMORRHAGE

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In 1928 Bagley (I–3) demonstrated the meningeal thickening that follows subarachnoid hemorrhage and also showed in animals that communicating hydrocephalus could result. Since that time the sequelae of bleeding into the subarachnoid space have been well recognized, and cases of communicating hydrocephalus following subarachnoid hemorrhage have been reported (4–14). These were either autopsy findings on patients with subarachnoid hemorrhage or studies on patients in whom communicating hydrocephalus was suspected because of clinical findings. These patients were obviously selected for reasons other than subarachnoid hemorrhage and may not reflect the true incidence of communicating hydrocephalus.

METHODS AND TECHNIQUES

The patients in this study are those who have persistently xanthochromic spinal fluid or bloody spinal fluid with a bleeding lesion confirmed angiographically and at surgery.

Some patients were studied during their initial hospitalization for hemorrhage and others on follow-up visits as outpatients. The study includes most of the subarachnoid hemorrhage patients seen at this hospital in the past 6 months with the exception of those who did not survive long enough to be studied. The test which we have used is isotope cisternography using 100 μCi of high specific activity IHSA 7 and the Pho/Gamma III scintillation camera. The isotope is injected into the subarachnoid space via lumbar puncture using no diluent, and anterior and left lateral views of the head are obtained routinely at 2, 4 and 24 hr. The halo of activity seen on several of the 2- and 4-hr scans (see Figs. 2, 4, 5) is produced by a marker tube containing 203Hg to give an outline of the head. To date we have done approximately 100 cistern scans all by the lumbar route.

Figure 1 shows what we consider a completely normal cistern scan. This is in agreement with other investigators (15–20). Many of those considered normal had air studies which confirmed the scan findings.

Figure 2 illustrates an example of communicating hydrocephalus with complete tentorial block. These criteria are the same that other investigators use for a positive diagnosis of communicating hydrocephalus (15,18–20). They have been confirmed by ourselves and others by pneumoencephalography and the response to an atroventricular shunt.

RESULTS

The results are summarized in Table 1.

Our study to date includes 21 patients, 10 of whom were shown to have communicating hydrocephalus. Eight of these 10 have received atroventricular shunts. All have shown clinical improvement, except one who died from complications of his aneurysm surgery. Of the two positives who did not receive atroventricular shunts, one died before surgery could be performed and one is asymptomatic. He is being followed closely as an outpatient.

Twelve patients bled from aneurysms and, of these, six developed communicating hydrocephalus. Scans were obtained 3 weeks to 6 months following hemorrhage. In four patients the site of bleeding was never determined. One of these was found to have hydrocephalus.

Three patients had subdural hematomas with subarachnoid bleeding and were treated surgically. Two of these patients developed hydrocephalus. The third did not have hydrocephalus, but the cisternogram demonstrated the subdural hematoma which was unsuspected clinically. It was subsequently confirmed

* RISA-H Abbott, 50 μCi/mg Alb 10 mg Alb/cc.

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by encephalography, arteriography and surgery. The scan and pneumoencephalogram are shown in Fig. 3.

One patient bled from an arteriovenous malformation arising from the ascending frontoparietal artery and developed hydrocephalus. He has done well since shunting.

One patient had subarachnoid hemorrhage associated with a left parietal glioma and did not have hydrocephalus. However, the scan did suggest the presence of the mass as shown in Fig. 4.

**DISCUSSION**

It is known that the clinical criteria for the diagnosis of communicating hydrocephalus are not always reliable (6,8,9).

The radiographic criteria for a diagnosis of communicating hydrocephalus may also be questioned. Kibler et al (9) stated that they failed to get air over the convexities in only one out of 150 normal air encephalograms while Granholm and Radberg (7) failed in six out of 36 normal patients. Some of these failures may be attributed to the technique of performing the study. Failure to demonstrate dilated sulci makes the encephalographic differentiation of communicating hydrocephalus from atrophy very difficult. The converse is also true. Isotope cisternography can be useful in making the differentiation as Fig. 5 shows. There was good correlation between cisternogram and pneumoencephalogram in all cases where both were performed.

Air encephalography has the added disadvantage of considerable morbidity, especially in patients with communicating hydrocephalus. The patient illustrated in Fig. 5 became comatose following the air

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**TABLE 1. RESULTS OF ISOTOPE CISTERNOGRAPHY ON SUBARACHNOID HEMORRHAGE PATIENTS**

<table>
<thead>
<tr>
<th>Source of hemorrhage</th>
<th>Total number</th>
<th>Number shown to have communicating hydrocephalus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intracranial aneurysm</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td>Unknown</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Trauma with subdural</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>hematoma</td>
<td></td>
<td></td>
</tr>
<tr>
<td>A-V malformation</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Hemorrhage from tumor</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Totals</td>
<td>21</td>
<td>10</td>
</tr>
</tbody>
</table>

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**FIG. 1.** Normal cisternogram. Anterior and left lateral scans at 2, 4 and 24 hr show that isotope ascends normally through basal and Sylvian cisterns with symmetrically layered over convexities of hemispheres and in sagittal fissure at 24 hr. Note high concentration in parasagittal area seen on both anterior and lateral scans.
FIG. 2. 63-year-old man was admitted because of 12-month history of progressive dementia. On lateral and anterior scans at 24 hr, activity is seen in basal cisterns and cisterna magna. Dilated ventricular system is well outlined with activity persisting on 24-hr scan. At no time is any activity seen above level of tentorial incisura.

FIG. 3. 36-year-old man had grand mal seizure following head trauma in automobile accident and had mild amnesia at admission. There were no other neurological abnormalities. Lumbar puncture with cisternogram 5 days post-trauma revealed slightly xanthochromic spinal fluid. (A) Anterior cisternograms at 2, 4 and 24 hr show displacement of sagittal activity from left to right, depression of sylvian fissure and obliteration of subarachnoid space over left hemisphere. Patient did well following surgical evacuation of his left subdural hematoma. (B) Pneumoencephalogram showed classical global displacement of subdural hematoma.

proven completely reliable, and we have studied all these patients with pneumoencephalography before making a definitive diagnosis.

There has been no greater morbidity than from a routine lumbar puncture, and we feel that the test is safe when performed as suggested. Considering its safety, reliability, cost and availability on an outpatient basis, it has proven ideal for the study which we undertook.

We do not contend that cisternography alone can always make the diagnosis, but it is a reliable screening test which in many cases is the only study necessary. Figure 6 shows the cistern scan on such a patient. This 60-year-old white male had an internal carotid artery aneurysm ligated surgically and 4 weeks later he remained disoriented, bed-ridden and had shown little or no improvement. A diagnosis of communicating hydrocephalus due to a block at the tentorial incisura was made on the cistern scan, and without further studies the patient received an atrioventricular shunt. He has subsequently become neurologically normal and returned to work.

In most of our patients, we have also used the IHSA clearance test as described by Abbott and Alksne (27). Basically the test involves counting the isotope before lumbar injection and measuring the activity present in the peripheral blood at 24 hr. In a few cases it has been of some help. However, it is subject to both false negatives and positives due to faulty injection and other technical errors. After performing both the cisternogram and clearance test on our first 65 patients, we felt it was of little value without a cisternogram.

CONCLUSIONS

The figures shown in the table do not necessarily represent the true incidence of communicating hy-
A 54-year-old man was admitted in comatose state. Lumbar puncture revealed grossly bloody spinal fluid. Anterior cisternograms at 2, 4 and 24 hr show blunting and depression of sylvian fissure and obliteration of subarachnoid space over convexity on side of tumor. Tumor was confirmed by arteriography and at autopsy. No shunt procedure was performed.

Hydrocephalus following subarachnoid hemorrhage. The incidence of hydrocephalus that we have found does suggest that screening of subarachnoid hemorrhage patients with isotope cisternography can detect unsuspected cases of communicating hydrocephalus and allow surgical treatment before permanent neurological damage has been sustained.

It should also be possible to establish the overall incidence of communicating hydrocephalus following subarachnoid hemorrhage. As the number of patients increases and as serial studies are made, it should be possible to determine which bleeding lesions are most likely to cause hydrocephalus and at what time after hemorrhage it will become evident.

SUMMARY

Isotope cisternography using high specific activity IHSA was performed on 21 patients following subarachnoid hemorrhage from various sources. Ten of these were found to have communicating hydrocephalus. There was a higher incidence of communicating hydrocephalus in patients with aneurysms about the Circle of Willis than in those with middle cerebral or posterior cerebral artery aneurysms.

FIG. 4. 54-year-old man was admitted in comatose state. Lumbar puncture revealed grossly bloody spinal fluid. Anterior cisternograms at 2, 4 and 24 hr show blunting and depression of sylvian fissure and obliteration of subarachnoid space over convexity on side of tumor. Tumor was confirmed by arteriography and at autopsy. No shunt procedure was performed.

FIG. 5. 53-year-old male had undergone surgery for left parietal and posterior fossa subdural hematomas. He had residual right hemiparesis which remained unchanged between admissions. For several months before second admission, there was history of slowly progressive dementia. Fall with head trauma precipitated second admission to rule out another subdural hematoma. (A) Anterior-posterior brow-up pneumoencephalogram film shows dilated ventricles and small amount of air in right sylvian fissure and over right convexity. These findings do not allow definitive diagnosis of either atrophy or communicating hydrocephalus. (B) Cisternogram, which was done before air encephalogram, shows filling of dilated ventricles with some isotope activity in sylvian fissure and over right convexity at 24 hr. This meets our criteria for diagnosis of communicating hydrocephalus with incomplete block at tentorium. The patient responded well to atrioventricular shunt.
REFERENCES


