Hydrocephalus following spontaneous subarachnoid hemorrhage

Clinical features and treatment

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Twenty-eight cases of communicating hydrocephalus after subarachnoid hemorrhage (SAH) due to ruptured intracranial aneurysms are reported. The relationship between the incidence of this complication and the various clinical features of SAH is discussed. The findings of RISA cisternography have little relationship to the findings of pneumoencephalography or the results of shunting procedures. The availability and value of echoencephalography in treating such patients is emphasized.

Key Words • subarachnoid hemorrhage • communicating hydrocephalus • RISA cisternography • ventriculocranial index • echoencephalography • shunt

Communicating hydrocephalus is now a well-recognized complication of subarachnoid hemorrhage (SAH) due to ruptured intracranial aneurysm. It is attributed to an adhesive reaction in the basilar cisterns, over the cerebral convexity, and at the incisural region of the tentorium following SAH.6,7,9,10,12,13

In reporting the results of intracranial operation in a series of 250 aneurysms we noted that communicating hydrocephalus was frequently a problem.11

This paper reports the clinical features of 28 cases of hydrocephalus out of 280 cases with aneurysm. The results of treatment with shunting procedures are also discussed.

Review of Clinical Material

The 28 patients are divided into two groups. In Group 1 (21 cases) the diagnosis was made following craniotomy; in Group 2 (7 cases) the diagnosis and treatment were carried out prior to operation (2 cases) or the aneurysms were not treated by craniotomy at all (5 cases). Hydrocephalus complicated 9% of the operated cases and 15% of the unoperated cases plus those cases in which the shunting procedure was performed prior to craniotomy.

Age and Sex

The distribution of cases according to age is shown in Table 1 and is not significantly

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<table>
<thead>
<tr>
<th>Factor</th>
<th>Cases of Hydrocephalus</th>
<th></th>
<th>%</th>
<th>% SAH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient's age (yrs):</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>under 20</td>
<td>1</td>
<td>4</td>
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<td>3</td>
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<tr>
<td>20–40</td>
<td>8</td>
<td>29</td>
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<td>35</td>
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<td>41–60</td>
<td>15</td>
<td>53</td>
<td></td>
<td>53</td>
</tr>
<tr>
<td>over 60</td>
<td>4</td>
<td>14</td>
<td></td>
<td>9</td>
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<tr>
<td>Aneurysm location (artery):</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>internal carotid</td>
<td>3</td>
<td>10</td>
<td></td>
<td>10</td>
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<tr>
<td>middle cerebral</td>
<td>8</td>
<td>27</td>
<td></td>
<td>19</td>
</tr>
<tr>
<td>posterior communicating</td>
<td>4</td>
<td>13</td>
<td></td>
<td>26</td>
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<tr>
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<td>11</td>
<td>40</td>
<td></td>
<td>38</td>
</tr>
<tr>
<td>anterior cerebral</td>
<td>2</td>
<td>10</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>verteobasilar</td>
<td>2</td>
<td>10</td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>No. of SAH’s:</td>
<td></td>
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</tr>
<tr>
<td>1</td>
<td>9</td>
<td>32</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>10</td>
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<tr>
<td>3 and over</td>
<td>9</td>
<td>32</td>
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<td>Botterell Grade:</td>
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<tr>
<td>1</td>
<td>3</td>
<td>11</td>
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<td>18</td>
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<tr>
<td>2</td>
<td>3</td>
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<td></td>
<td>17</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>6</td>
<td></td>
<td>3</td>
</tr>
</tbody>
</table>

is given by the clinical grades of the patient (Botterell's classification8) prior to surgery (Table 1). Grade 4 and 5 patients displayed a greater frequency and patients of Grades 1, 2, and 3 a lesser frequency than would have been expected.

From the standpoint of associated hematomas, 11 patients (50%) of those with craniotomy had an intracranial hematoma (10 cases with intracerebral hematoma and one case with subdural hematoma). By contrast, cases with intracranial hematoma represented only 15% of all the patients subjected to craniotomy for aneurysm in our entire series.

**Clinical Features**

It is difficult to assess the symptomatology specifically related to the presence of communicating hydrocephalus because of complicating factors of recent SAH and craniotomy. Nonetheless, certain symptoms were considered to be more characteristic of hydrocephalus. The development of a psycho-organic syndrome (POS) characterized by disorientation, impaired memory, a decrease in mental and physical activity, and lack of concentration was relatively common. Spastic gait and urinary incontinence were also encountered. All of our patients exhibited these features in some degree including six patients with akinetic mutism.

**Site of Aneurysm**

The relation of communicating hydrocephalus to the location of the aneurysm is shown in Table 1. In comparison to the distribution of aneurysms in the entire series, middle cerebral aneurysms had a higher incidence and posterior communicating aneurysms a lower incidence than would have been expected. Two cases with multiple aneurysms are also included in this series.

**Number of SAH’s**

The relationship between the number of bleeding episodes and the development of communicating hydrocephalus is shown in Table 1. It is apparent that two thirds of the patients had a history of spontaneous SAH occurring two or more times.

**Severity of Hemorrhage**

A measure of severity of the hemorrhage

![Fig. 1. Graph comparing the time interval between the last SAH or craniotomy and the shunt operation.](image-url)
Since the onset of these symptoms is insidious, it is also difficult to assess the exact time of onset of the hydrocephalus so as to correlate it with SAH or craniotomy. The time interval between the last SAH or craniotomy and the shunt operation is a rough measure of the time required for the development of the hydrocephalus (Fig. 1). One month was the most frequent interval found in our study; that is, hydrocephalus was recognized most frequently within a month after the last SAH or craniotomy.

Diagnostic Procedures

Three procedures were used as aids in diagnosing communicating hydrocephalus and evaluating the results of treatment: echoencephalography, RISA cisternography, and pneumoencephalography (PEG).

Echoencephalography is of great value in evaluating these patients for three reasons: 1) to exclude an intracranial hematoma by shifts of the midline echo; 2) to assess the degree of hydrocephalus by measuring third ventricular width; and 3) to assess the functioning of the shunt by following changes in third ventricular width. A value greater than 7 mm for third ventricular width is pathological.\(^{15}\) Echoencephalography was performed in eight cases. Figure 2 illustrated some typical cases followed with echoencephalography. The symptomatology of these patients coincided well with changes of third ventricular width.\(^{4}\)

RISA cisternography was used in 19 of the 28 cases, which were then classified according to the three categories that we recognize in our clinic. 1) First degree malabsorption, “hydrocephalus malresorptivus,” (4 cases) corresponds to Group B of Bannister, \textit{et al.},\(^{2}\) and is characterized by a small amount of activity penetrating the ventricular system, and a large amount of activity over the cerebral convexity in the 24-hour scan. 2) Second degree malabsorption, “hydrocephalus malresorptivus II,” (8 cases) is characterized by a large amount of activity penetrating the ventricular system with a slight degree of activity over the cerebral convexity in the 48-hour scan.

![Graph](https://via.placeholder.com/150)

Fig. 2. Graph plotting the changes in the width of the third ventricle in two typical cases, as determined by echoencephalography. (Courtesy of Dr. Bücking.)
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3) No absorption, "hydrocephalus aresorptivus," (5 cases) corresponds to Bannister's Group A and is characterized by a large amount of activity penetrating the ventricular system with no activity over the cerebral convexity in the 48-hour scan. There were also two cases with normal RISA cisternography except for high uptake at the site of craniotomy ("activity depot").

The degree of hydrocephalus was determined by measurement of the ventriculocranial index (VC index) by means of PEG in 12 cases. This index is derived from the anteroposterior view (brow-up) by dividing the lateral ventricular width (in mm) by half of the skull width (in mm). Normally the index is less than 0.3 while in hydrocephalus it is greater than 0.33. In all 12 cases except one (0.3) the index was more than 0.33. In one case a slight amount of air appeared over the cerebral convexity but the remaining cases showed retention of the air in the basilar cisterns.

Treatment with Shunting Procedure

All 28 patients were treated by ventriculoatrial shunt using the Pudenz-Heyer apparatus. Nineteen of the 28 cases improved; in 13 cases the improvement was obvious within a week. Three of six cases of akinetic mutism improved also after the procedure.

There was a good correlation between the value of the VC index and the results of shunting (Fig. 3). The larger the VC index, the better the results. By contrast, there was little relationship between the results of shunting and the findings of RISA cisternography (Fig. 4). This is further demonstrated by comparing the results of RISA cisternography to the VC index in each case (Fig. 5). Thus, in these patients abnormal findings on RISA cisternography did not correlate well with enlargement of the ventricular system or with good results from the shunting procedure.

Discussion

The frequency of hydrocephalus following SAH has been variously reported: about 10% according to Foltz,5 19% to Galera and Greitz,7 30% to Heidrich,8 42.8% to Pertuiset, et al.,13 and 43% to Schiefer and Kanzner.15 The latter figure is based on the findings of echoencephalography. The frequency in our series corresponds to that of Foltz. It is difficult to assess the role of craniotomy in the development of hydrocephalus. As far as one can see from the percentages in our small series (9% of Group I and 15% of Group 2), craniotomy does not seem to play a significant aggravation role in hydrocephalus.7 Our series may even point to the contrary.

The rather high incidence of hydrocephalus complicating middle cerebral aneurysms in our series is in contrast to other
such “compensated” cases do not benefit from shunting procedures. Our findings suggest that RISA cisternography has limited value in the study of CSF dynamics particularly when applied to establishing the diagnosis of such communicating hydrocephalus or to assessing prognostic criteria for shunting procedures.

References

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