Management of Spontaneous Cerebellar Hematomas: A Prospective Treatment Protocol

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OBJECTIVE: To identify easily applicable guidelines for the surgical and conservative management of spontaneous cerebellar hematomas.

METHODS: A treatment protocol was developed and prospectively applied for the management of 50 consecutive cases of cerebellar hematomas. The appearance of the fourth ventricle, adjacent to the hematoma, on computed tomographic scans was divided into three grades (normal, compressed, or completely effaced). The degree of fourth ventricular compression was correlated with the size and volume of the hematoma and the presenting Glasgow Coma Scale (GCS) score. The hematoma was surgically evacuated for all patients with Grade III compression and for patients with Grade II compression when the GCS score deteriorated in the absence of untreated hydrocephalus. Patients with Grade I or II compression were initially treated with only ventricular drainage in the presence of hydrocephalus and clinical deterioration.

RESULTS: The degree of fourth ventricular compression was classified as Grade I in 6 cases, Grade II in 26, and Grade III in 18. The degree of fourth ventricular compression was significantly correlated with the volume of the hematoma ($r_s = 0.67, P < 0.0001$), hydrocephalus ($r_s = 0.44, P = 0.001$), the preoperative GCS score ($r_s = 0.43, P = 0.001$), the maximal diameter of the hematoma ($r_s = 0.43, P = 0.001$), and a midline location of the hematoma ($\chi^2 = 6.84, P < 0.009$). Acute deterioration in GCS scores occurred for 6 (43%) of 14 patients with Grade III ventricular compression who were conscious at presentation. Thirteen patients with Grade I or II ventricular compression and stable GCS scores of more than 13 were treated conservatively. Nine patients were treated with ventricular drainage only, and 28 underwent posterior fossa craniectomy and evacuation of the hematoma with ventricular drainage. The mortality rate at 3 months was 40%. None of the patients with Grade III fourth ventricular compression and GCS scores of less than 8 at the time of treatment experienced good outcomes. Overall, 15 (60%) of 25 patients with hematomas with maximal diameters of more than 3 cm and Grade I or II compression did not require clot evacuation.

CONCLUSION: Conscious patients with Grade III fourth ventricular compression should undergo urgent clot evacuation before deterioration. Surgical evacuation of the clot may not be required for large hematomas (>3 cm) if the fourth ventricle is not totally obliterated at the level of the clot.

Key words: Cerebellar hemorrhage, Glasgow Coma Scale, Hydrocephalus, Outcome

Spontaneous cerebellar hematomas represent 5 to 13% of all cases of spontaneous intracranial hemorrhage (3, 4, 9, 10, 12, 17). These hematomas are associated with high mortality rates of 20 to 75%, irrespective of the mode of treatment, with higher values being reported for the pre-computed tomography era (3, 4, 7, 8, 13, 14, 17, 25, 26). Current overall surgical mortality rates remain up to 20 to 50% (1, 3, 12, 13, 15, 17, 20, 22, 24, 28).

Management of grave cases, as well as treatment of patients in good neurological condition, can be straightforward; however, the group of patients between these two extremes poses a dilemma in decision-making during treatment (19). The depressed level of consciousness in cases of cerebellar hematomas could be attributable to hydrocephalus, direct brainstem compression by the hematoma and surrounding swelling, or both. Decision-making is required for selection of the
appropriate treatment option. In most cases, the decisions regarding surgical treatment are determined by the size of the hematoma and other factors, such as the presence of hydrocephalus, the degree of basal cisternal compression, and the location of the hematoma (9, 12–16, 18, 20, 23, 24, 28). The main controversy involves deciding which cases require surgical evacuation of the hematoma versus other options, such as ventricular drainage only or conservative treatment. Furthermore, because the clinical course is variable in some cases, the timing of such treatment should be carefully considered. Surgical evacuation of posterior fossa hematomas is associated with morbidity and mortality risks (12, 13, 21). Simple drainage of hydrocephalus may be ineffective (15, 17). There is a group of patients for whom conservative management is appropriate (12, 13, 16, 26, 28). Because there are currently no satisfactory guidelines regarding the management of spontaneous cerebellar hematomas, we attempted to treat 50 consecutive patients with this condition according to a set protocol, in a prospective study.

**PATIENTS AND METHODS**

**Protocol**

As a more direct indicator of mass effect within the posterior fossa, the configuration of the fourth ventricle was noted. We developed a grading system based on the computed tomographic (CT) appearance of the fourth ventricle. The appearance of the fourth ventricle was divided into three grades, as follows: Grade I, normal size and configuration, located in the midline (if intraventricular hemorrhage is present, cerebrospinal fluid [CSF] is still visible in the fourth ventricle); Grade II, partially compressed or distorted, shifted to the contralateral side (in cases of unilateral hematomas); Grade III, complete obliteration, with anterior shift distorting the brainstem and obliterating the prepontine space (even if the fourth ventricle is partially compressed).

The CT slice that demonstrated the largest transverse diameter of the hematoma was chosen for assessment of these grades (Fig. 1). Lower CT slices through the posterior fossa, in which the fourth ventricle is not normally identified, were avoided for assessments of the size, configuration, and grade of the fourth ventricle. The grades on the first CT scans, which were obtained within 24 hours after the ictus, were used to dictate the management protocol. All patients with a diagnosis of spontaneous cerebellar hematoma who were eligible for the study were assessed with respect to Glasgow Coma Scale (GCS) scores and the degree of fourth ventricular compression and were treated according to a set protocol (Fig. 2).

Evacuation of the hematoma was performed in all cases with Grade III fourth ventricular compression, even for patients with good consciousness levels, on the presumption that these patients were at risk of subsequent deterioration resulting from brainstem compression. A midline approach was used, and a bilateral suboccipital craniectomy was performed. The posterior arch of the atlas was resected, followed by opening of the dura. For midline hematomas, the transver-

![FIGURE 1. CT scans demonstrating different cerebellar hematomas and the appearance of the fourth ventricle on the axial CT slice with the largest transverse diameter for the hematoma. A, normal size and location (Grade I). B, partially compressed and shifted (Grade II). C, completely obliterated (Grade III).](image-url)

![FIGURE 2. Protocol scheme for the treatment of spontaneous cerebellar hematomas. CSF-D, CSF/ventricular drainage or shunt.](image-url)
mian approach was used; for hemispheric hematomas, the hematoma was approached through the relevant hemisphere. The hematoma was then evacuated, and hemostasis was secured. Ventricular drainage was performed concomitantly, because insertion of a ventricular drain only may carry the risk of upward transtentorial herniation in these cases. Patients with Grade I fourth ventricular compression whose GCS scores were more than 13 were initially monitored. If deterioration of consciousness occurred, then ventricular drainage was performed initially in the presence of hydrocephalus. If consciousness levels failed to improve after ventricular drainage or in the absence of significant ventriculomegaly, then evacuation of the hematoma was indicated. In cases with Grade I fourth ventricular compression, hematoma evacuation was considered to be unnecessary and ventricular drainage was required only if hydrocephalus developed, resulting in impaired consciousness.

Various features on the initial CT scans after presentation were also evaluated. The presence or absence of hydrocephalus was noted. The location of the hematoma (whether occupying the cerebellar hemisphere or the vermis) and the presence or absence of intraventricular hemorrhage were also noted. The size of the hematoma was assessed by calculating both the maximal transverse diameter and the volume. The volume of the hematoma was measured by calculating the area occupied by the hyperdense hematoma on each slice of the CT images and multiplying the area by the thickness of each slice. The quadrigeminal cistern was identified and the degree of compression was graded by using the method described by Taneda et al. (24), as follows: Grade I, normal appearance of the quadrigeminal cistern; Grade II, compression of the quadrigeminal cistern; Grade III, complete obliteration of the quadrigeminal cistern.

The Glasgow Outcome Scale scores at 3 months were used to assess outcomes. A good outcome was defined as the ability of the patient to be independent with respect to activities of daily living (Glasgow Outcome Scale score of 4 or 5).

Spearman ranked-sum analysis was used to quantify the correlations between various factors. In addition, the variables that were significantly correlated with clinical outcomes were determined by multivariate analysis of variance. The χ² test was used for categorical analysis.

Patient population

Between August 1991 and February 1999, 56 patients with spontaneous cerebellar hematomas were admitted to the neurosurgical unit of the General Infirmary at Leeds. Cases with traumatic causes or with an underlying neoplasm, aneurysm, or evident arteriovenous malformation were excluded from this analysis. Patients for whom CT scans demonstrated hemorrhage extending to, or originating from, the brainstem were also excluded.

The identification of excluding factors at the outset or during further investigation after treatment excluded a number of patients from the study. Six patients with spontaneous hematomas were excluded: three because of fixed dilated pupils, two for failure to follow the protocol, and one for dissemiated colonic metastatic disease. The sample in this study consisted of 50 cases. Of the 50 patients included in the study, there were 24 male and 26 female patients, ranging in age from 17 to 89 years (mean, 62 yr). A history of hypertension was noted for 18 patients (36%). Eleven patients had previously experienced a supratentorial ischemic stroke or cerebrovascular event. Nine patients were receiving anticoagulants.

The presenting GCS scores and the subsequent deterioration in consciousness levels before transfer to our department are summarized in Table 1. Signs of cerebellar dysfunction were observed for 36 patients.

RESULTS

The fourth ventricle was normally visible (Grade I) in 6 cases, compressed or distorted (Grade II) in 26 cases, and completely effaced (Grade III) in 18 cases. Hydrocephalus was identified in 37 cases. The maximal transverse diameter of the hematoma ranged between 2 and 7 cm (mean, 4.3 cm; median, 4 cm). The volume ranged from 10 to 46 ml (mean, 17 ml). The hematoma was confined to one cerebellar hemisphere in 17 cases, was in a midline or vermian location in 15 cases, and involved the hemisphere and vermis in 18 cases. The hematoma ruptured into the fourth ventricle in 25 cases, with variable extensions into other parts of the ventricular system. Obstructive hydrocephalus secondary to intraventricular hemorrhage was responsible for the deterioration in consciousness levels for 2 patients with Grade I fourth ventricular compression and 10 patients with Grade II compression. The quadrigeminal cistern was normally visible in 6 cases, compressed in 25 cases, and completely obliterated in 19 cases (Grades I to III, respectively).

The relationships between the grade of fourth ventricular compression, the presenting GCS score, and subsequent deterioration before treatment are presented in Table 2. Deterioration occurred in 12 (67%) of 18 cases with Grade III ventricular compression, at variable times after the initial presentation to the referring hospital and before transfer and admission to our neurosurgical center. Six (43%) of 14 patients experienced deterioration to a comatose state, from an initial GCS score of more than 9, before transfer to our unit. Most patients experienced deterioration within 12 hours after the ictus. These patients were treated immediately after admission to our department, on the basis of the initial CT appearance, because repeated imaging would result in further delays.

### Table 1. Glasgow Coma Scale Scores at Presentation for 50 Patients with Spontaneous Cerebellar Hematomas and the Number of Patients with Subsequent Deterioration in Consciousness Levels

<table>
<thead>
<tr>
<th>GCS Score</th>
<th>No. of Patients at Presentation</th>
<th>No. of Patients at the Time of Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3–8</td>
<td>7</td>
<td>19</td>
</tr>
<tr>
<td>9–12</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>13–15</td>
<td>35</td>
<td>21</td>
</tr>
</tbody>
</table>

* GCS, Glasgow Coma Scale.

* Or last GCS score before intubation and ventilation.
TABLE 2. Clinical Deterioration in the Various Grades of Fourth Ventricular Compression

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of Patients</th>
<th>% in Coma Initially</th>
<th>% With Deterioration</th>
<th>% Finally in Coma</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>33</td>
</tr>
<tr>
<td>II</td>
<td>26</td>
<td>4</td>
<td>38</td>
<td>27</td>
</tr>
<tr>
<td>III</td>
<td>18</td>
<td>22</td>
<td>67</td>
<td>56</td>
</tr>
</tbody>
</table>

*GCS, Glasgow Coma Scale.

**Grades of fourth ventricular compression.

† Any decrease in GCS scores (not necessarily to coma).

‡ GCS score of less than 8.

in management. A few patients experienced deterioration up to 48 hours later. These three patients underwent repeated CT scanning before surgery; the size of the hematoma and the grade of fourth ventricular compression were unchanged, but the quadrigeminal cisterns had become obliterated with increased ventriculomegaly.

The relationships between the fourth ventricular grade, the site of the hematoma, the extent of hydrocephalus, and the size of the hematoma are presented in Table 3. The correlation between the grade of fourth ventricular compression and the volume of the hematoma was strong ($r_1 = 0.67, P < 0.0001$). The correlations of the fourth ventricular grade with the degree of hydrocephalus, preoperative GCS score, and hematoma diameter were significant ($r_2 = 0.44, P = 0.001; r_3 = 0.43, P = 0.001; r_4 = 0.43, P = 0.001$). Hydrocephalus was also significantly correlated with the degree of quadrigeminal cistern compression ($r_5 = 0.43, P = 0.001$). The number of patients with Grade III ventricular compression was significantly greater among patients with hematomas located in the midline, compared with patients with hematomas located in the cerebellar hemispheres ($\chi^2 = 6.84, P < 0.009$). As determined by using analysis of variance, clinical outcomes at 3 months were best correlated with the fourth ventricular grade ($P < 0.002$) and the preoperative GCS score ($P < 0.003$).

Surgical treatment

Thirteen patients with GCS scores of more than 13, small hematomas, and no significant hydrocephalus were treated conservatively, with close neurological observation. Twenty-eight patients were treated with evacuation of the hematoma, via a suboccipital craniectomy, and ventricular drainage. Of these, three patients initially underwent ventricular drainage but, because of their failure to experience improvement, a subsequent operation to evacuate the hematoma was performed. Nine patients underwent ventricular drainage only. Eight patients underwent ventriculoperitoneal shunt insertion; of these, three patients had undergone posterior fossa decompression, one had undergone previous placement of an external ventricular drain, and four had received ventriculoperitoneal shunts as the primary treatment. Patients who were receiving anticoagulants were treated according to the protocol, but surgery was delayed until the coagulopathy was corrected after administration of fresh frozen plasma and vitamin K.

The relationship between management and the grade of fourth ventricular compression is demonstrated in Table 4. Fifteen (60%) of 25 patients with hematoma diameters of more than 3 cm on initial CT scans were treated without hematoma evacuation when the fourth ventricle was not totally compressed. Good outcomes were achieved for 67% of these 15 patients. Three patients with cerebellar hematomas more than 3 cm in diameter and Grade I ventricular compression did not undergo hematoma evacuation, and all three experienced good outcomes. Of the 22 patients with hematomas greater than 3 cm and Grade II fourth ventricular compression, 55% experienced good recoveries; less than one-half of those patients (10 of 22 patients) underwent hematoma evacuation.

Five patients with Grade II fourth ventricular compression and GCS scores of more than 13 experienced deterioration while being monitored in our department. Of these, three patients experienced improvement after CSF drainage and one patient did not experience improvement after CSF drainage and underwent evacuation of the hematoma. All of these four patients experienced good outcomes. The fifth patient with a GCS score of 13 died as a result of a pulmonary embolism. The treatment of patients with Grade II fourth ventricular compression is presented in Table 5.

Outcomes

The overall mortality rate was 40% (20 patients) at 3 months. Six patients died as a result of causes other than the posterior

TABLE 3. Computed Tomographic Characteristics for the Various Grades of Fourth Ventricular Compression

<table>
<thead>
<tr>
<th>Grade</th>
<th>No. of Patients</th>
<th>Mean Hematoma Diameter (cm)</th>
<th>Mean Hematoma Volume (ml)</th>
<th>Midline Hematomas (%)</th>
<th>Hydrocephalus Present (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>6</td>
<td>3</td>
<td>9</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>II</td>
<td>26</td>
<td>4.2</td>
<td>15</td>
<td>42</td>
<td>61</td>
</tr>
<tr>
<td>III</td>
<td>18</td>
<td>5</td>
<td>27</td>
<td>78</td>
<td>100</td>
</tr>
</tbody>
</table>
fossa hematoma, i.e., a traumatic acute subdural hematoma after a fall, lower gastrointestinal bleeding from an ischemic bowel, a cardiac arrhythmia attributable to ischemic heart disease, an extensive infarction involving the left cerebral hemisphere, hemorrhage resulting from a tracheostomy, and a pulmonary embolism. The mortality rate was 54% (15 of 28 patients) among patients treated with surgical evacuation of the hematoma and 27% among patients treated with ventricular drainage only. The three patients who were initially treated with CSF drainage and required subsequent evacuation of the hematoma because of failure to exhibit improvement experienced good outcomes. Overall, the mortality rate for patients more than 65 years of age was 48%, compared with 30% for the younger age group. At 3 months, 80% of the surviving patients (24 of 30 patients) exhibited good Glasgow Outcome Scale scores of 4 or 5. Of the patients who were receiving anticoagulants before treatment, 55% experienced good outcomes despite the delay in surgical treatment attributable to reversal of their coagulation abnormality. The outcomes for the various treatment groups are presented in Tables 4, 5, and 6.

DISCUSSION

Causes

Hypertension is the major cause of cerebellar hematomas and was present in 36% of our patients. A hypertensive cause has been reported to be responsible for 60 to 89% of cases (1, 3, 4, 7, 10, 14, 15, 17, 20, 22). Hypertensive cerebellar hemorrhage constitutes 5 to 10% of all hypertensive intracranial hemorrhage cases (7). Cerebral amyloid angiopathy was also reported as a significant cause of cerebellar hemorrhage in old age (10).

Evidence of cerebrovascular disease affecting other areas of the brain is common. Among 52 cases reported by Dinsdale (4), a previous history of ischemic cerebral infarction was noted in 51.3% of cases and hemorrhagic infarction in 20.9% of cases. Other series reported 15 to 20% incidences of previous histories of cerebrovascular disease (7, 25). In 22% of our cases, a significant cerebrovascular event had occurred previously.


<table>
<thead>
<tr>
<th>Group</th>
<th>No. of Patients</th>
<th>Initial Treatment</th>
<th>Subsequent Treatment</th>
<th>Good Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade III + GCS score of &lt;8</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CSF Drainage Only</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Conservative</td>
<td>1 VP shunt</td>
<td></td>
</tr>
<tr>
<td>Grade III + GCS score of &gt;8</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>3 (38%)</td>
</tr>
<tr>
<td>Grade II + GCS &lt;8</td>
<td>7</td>
<td>3</td>
<td>4</td>
<td>4 (57%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2 VP shunts</td>
<td></td>
</tr>
<tr>
<td>Grade II + GCS score of &gt;8</td>
<td>19</td>
<td>4</td>
<td>6</td>
<td>11 (58%)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1 VP shunt</td>
<td></td>
</tr>
<tr>
<td>Grade I</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>6 (100%)</td>
</tr>
</tbody>
</table>

*GCS, Glasgow Coma Scale; CSF, cerebrospinal fluid; VP, ventriculoperitoneal.

After initial treatment by CSF drainage only.

TABLE 5. Treatment of Patients with Grade II Fourth Ventricular Compressiona

<table>
<thead>
<tr>
<th>Management Group</th>
<th>No. of Patients</th>
<th>GCS Score of &lt;8 (%)</th>
<th>Hematoma Diameter</th>
<th>Outcome (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>&gt;3 cm</td>
<td>&lt;3 cm</td>
</tr>
<tr>
<td>Observation</td>
<td>9</td>
<td>0</td>
<td>7 of 9</td>
<td>2 of 9</td>
</tr>
<tr>
<td>CSF drainage</td>
<td>7</td>
<td>29</td>
<td>5 of 7</td>
<td>2 of 7</td>
</tr>
<tr>
<td>Evacuation of hematoma</td>
<td>10</td>
<td>50</td>
<td>10</td>
<td>0</td>
</tr>
</tbody>
</table>

*CSF, cerebrospinal fluid; GCS, Glasgow Coma Scale.

bGOS scores of 4 or 5.

cOf the deaths in these two groups, 60% were directly related to systemic extracranial complications.

TABLE 6. Outcomes for the Different Grades of Fourth Ventricular Compression and the Relationships between Outcomes and the Size of the Hematoma and the Glasgow Coma Scale Scorea

<table>
<thead>
<tr>
<th>Good Outcomeb (%)</th>
<th>Grade I</th>
<th>Grade II</th>
<th>Grade III</th>
</tr>
</thead>
<tbody>
<tr>
<td>No coma (GCS score of &gt;8)</td>
<td>100</td>
<td>58</td>
<td>38</td>
</tr>
<tr>
<td>Coma (GCS score of &lt;8)</td>
<td>100</td>
<td>57</td>
<td>0</td>
</tr>
<tr>
<td>Hematoma of &lt;3 cm</td>
<td>100</td>
<td>75</td>
<td>No patients</td>
</tr>
<tr>
<td>Hematoma of &gt;3 cm</td>
<td>100</td>
<td>55</td>
<td>17</td>
</tr>
<tr>
<td>Overall</td>
<td>100</td>
<td>58</td>
<td>17</td>
</tr>
</tbody>
</table>

*a GCS, Glasgow Coma Scale.
bGlasgow Outcome Scale score of 4 or 5 at 3 months.
Clinical course

Both the clinical presentation and subsequent course are variable among cases. Unpredictable rapid deterioration in consciousness levels has been recognized (2, 7, 8, 15, 16, 20, 22). The majority of patients who experience deterioration from being conscious at presentation experience that deterioration primarily within 72 hours after onset (7, 15–17, 20). Acute presentation was observed to be correlated with poor outcomes (6, 17, 20). Approximately one-third of patients who experience deterioration from being conscious at presentation experience that deterioration primarily within 72 hours after onset (7, 15–17, 20). With the widespread availability of imaging, it is being increasingly recognized that a group of patients with cerebellar hematomas experience a more benign course (3, 8, 13, 14, 18, 25).

Current management

When surgery is indicated, controversy exists regarding whether ventricular drainage only, evacuation of the hematoma, or both procedures should be performed. Some surgeons recommend drainage of hydrocephalus as the only or initial procedure in all cases (6, 23, 26). Others recommend evacuation of the hematoma whenever surgery is indicated (7, 9, 12, 14, 15, 17, 22, 28).

Posterior fossa craniectomy and evacuation of the hematoma are not without risks (12, 13, 21). Postoperative recurrent hemorrhage can be fatal (7, 13, 20, 22, 26). In our series, the rate of postoperative death resulting from general causes was increased among patients with preexisting suboptimal general conditions and among patients in the older age group, when patients were subjected to surgery and anesthesia. Death may also occur among patients treated conservatively (2). Ventricular drainage alone was observed to be ineffective in some cases (15–17, 26). Outcomes after nonsurgical management were variable, with mortality rates between 9 and 75%, because surgery was not attempted for patients considered to be at high risk in many series, whereas primarily patients in good neurological condition were included in other series (3, 7, 12, 13, 20, 24, 28).

Management protocol

The 50 consecutive patients with cerebellar hematomas in our series were prospectively selected for a treatment modality according to the set protocol. The protocol was based on the degree of fourth ventricular compression on initial CT scans and the GCS score at the time of treatment. This was not a randomized study, because withholding surgical evacuation from patients with large hematomas compressing the fourth ventricle was considered to be inappropriate, as was subjecting patients with small hematomas who were fully conscious to posterior fossa decompression and evacuation of the hematoma. Because previous data on the clinical course of patients with partial fourth ventricular compression were lacking, caution was exercised in the treatment of patients with Grade II compression in our protocol. In our series, patients with Grade II compression who were conscious at presentation were initially carefully monitored. If deterioration in consciousness levels occurred, the most likely cause was hydrocephalus, which responded to ventricular drainage. The frequent presence of intraventricular hemorrhage may explain the delayed obstructive hydrocephalus without necessarily explaining the development of increased brainstem compression. Hematoma evacuation was the initial management approach when the GCS score decreased in the absence of significant ventriculomegaly in cases with Grade II compression. It must be emphasized that close observation should be instituted if a conservative approach is adopted, because significant deterioration before treatment could result in poor outcomes.

We re-emphasize that the management protocol was based on the initial CT appearance after hemorrhage. We admit that, in this study, not enough patients underwent repeated CT scanning before treatment. It is unknown to what extent a change in the fourth ventricular grade on serial scans or a delay between hemorrhaging and scanning would influence the management categorization.

Because this was not a randomized study, most of the supportive evidence for the management protocol was observational. In our series, severe compression of the fourth ventricle (Grade III) on the initial CT scans was associated with low GCS scores at presentation and poor outcomes. Furthermore, identification of this radiological sign predicted the subsequent clinical course. Among the group of patients presenting with Grade III ventricular compression, 43% of initially conscious patients experienced rapid deterioration into coma before admission to our neurosurgical department.

The configuration of the fourth ventricle was directly related to the mass effect exerted by the hematoma in the posterior fossa. Compression of the fourth ventricle by cerebellar hematomas has been previously described as indicating a “tight posterior fossa” (27). The fourth ventricular appearance grades were well correlated with hematoma volumes and clinical courses. Areas of swelling surrounding hematomas and exerting mass effect would also affect the fourth ventricular grade. This indicates the possible value of this radiological sign as an indicator of the degree of brainstem compression. It is less affected by the degree of hydrocephalus than is quadrigeminal cisternal compression and therefore may facilitate selection of the surgical procedure, i.e., hematoma evacuation versus ventricular drainage only. Some authors regarded the resulting hydrocephalus as an indication of brainstem compression (16, 27). Obstructive hydrocephalus can result from the presence of intraventricular hemorrhage, which explains the occasional lack of correlation between the degree of fourth ventricular compression and hydrocephalus. Hematoma evacuation was performed in all cases with Grade III fourth ventricular compression and in 38% of cases with Grade II compression. These grades of fourth ventricular compression can be easily identified in inspections of CT scans. In cases in which the hematoma has ruptured into the fourth ventricle, the presence of CSF surrounding the incompressible intraventricular clot should be noted and included as Grade I. The fourth ventricular grades should be considered with other factors, especially GCS scores, during the management of cerebellar hematomas.
GCS scores are well correlated with outcomes and can predict the results of surgery. Surgical mortality rates are increased with decreased preoperative levels of consciousness (1, 9, 12, 16, 17, 20, 22, 26). Mortality rates were 53 to 79% when surgery was performed after the onset of coma, whereas they were less than 25% if the patients were still conscious (6, 12, 20, 22). Others observed that the level of consciousness had no consistent bearing on outcomes and could not predict a benign course (18). Some deeply comatose patients may still benefit from surgical treatment (3, 15, 16, 22).

High scores (GCS scores of >13) are used in the selection of patients suitable for conservative treatment (12, 13, 25). However, the deterioration in GCS scores can be abrupt and associated with irreversible damage (2, 3, 7, 8, 15, 20, 22). The design of our management protocol considered early aggressive treatment for a selected group of patients with Grade III compression who were fully conscious. Deterioration in consciousness levels can be abrupt; therefore, observation was not considered an option, because outcomes were correlated with the level of consciousness at the time of treatment in other series (1, 9, 12, 16, 17, 20, 22, 26).

Other factors

The size of the hematoma was observed to be strongly correlated with outcomes in some series (12, 28). Zieger et al. (28) demonstrated a strong correlation between the clinical course and the volumetrically calculated size of the hematoma on CT scans. This was true in other series only when size was considered with other factors, such as the presence of hydrocephalus or the location of the hematoma within the cerebellum (13, 14, 20). However, other series failed to demonstrate correlation of the hematoma size with outcomes or clinical courses (18, 24, 25). A diameter of more than 3 to 4 cm or a volume of more than 15 ml for a cerebellar hematoma has been considered by many surgeons to be an indication for surgical evacuation, despite the presence of hematomas of more than 3 cm in diameter. The outcomes were good in 67% of cases.

In some series, hydrocephalus was observed to be the most important factor determining outcomes (20, 23). The presence of hydrocephalus was associated with poor prognoses in many series (5, 18, 24, 26). The presence of hydrocephalus has been used as a strong indicator for surgical treatment (9, 13, 14, 18, 20, 23, 24). Shenkin and Zavala (23) stated that direct surgical intervention was unnecessary and treatment should be directed toward the relief of hydrocephalus. In one series, the presence of hydrocephalus invariably resulted from brainstem compression and it was suggested that the presence of hydrocephalus necessitated a posterior fossa craniectomy and evacuation of the hematoma (16). This was not the case in our series, as demonstrated by the clinical features and outcomes of patients with Grade I or II ventricular compression with hydrocephalus, who were treated with CSF drainage only.

For some patients, ventricular drainage alone is ineffective and direct brainstem compression plays the predominant role in their poor neurological state (16, 26). Patients who are initially treated with external ventricular drainage may subsequently require craniectomy and evacuation of the lesion, but this fails to reverse the deterioration in some cases (16). This supports the need for methods to identify the appropriate initial treatment before further irreversible neurological damage occurs. In the presence of a large posterior fossa mass, ventricular drainage alone is thought to carry a risk of upward coning (25).

Taneda et al. (24) reported 75 cases of spontaneous cerebellar hemorrhage (all assessed with CT scans), with emphasis on the appearance of the quadrigeminal cisterns. Obliteration of the quadrigeminal cisterns on the CT scans was classified into three grades, i.e., normal (Grade I), compressed (Grade II), or absent (Grade III). Good outcomes were reported in 88.4, 68.8, and 0% of Grade I, II, and III cases, respectively. The degree of quadrigeminal cistern obliteration was also observed by others to be a good predictor of outcomes (5, 15, 26). Perimesencephalic cistern obliteration has also been reported to occur with progressive hydrocephalus in cases of shunt malfunction in the absence of posterior fossa masses, and the appearance of the cisterns returns to normal after shunt revision (11). Similar findings were observed for five of our patients, for whom the degree of hydrocephalus directly affected the appearance of the quadrigeminal cistern (data not shown). Furthermore, Taneda et al. (24) noted that the size of the hematoma was unrelated to the degree of cisternal compression. This indicates that the degree of cisternal compression is related mainly to the presence of hydrocephalus and less so to the size of the hematoma.

The location of the hematoma within the cerebellum, whether peripherally in the hemisphere or in the midline occupying the vermis, may affect the outcome and therapeutic decision-making (13, 18). The site of the hematoma is usually near or at the dentate nucleus and is less commonly in the vermis (4, 7, 15). Hematomas are usually located in the superior cerebellar artery territory (7). Autopsy studies demonstrated a low incidence of hemorrhage extending into the brainstem (7, 22). The importance of the location is related to brainstem compression. In our series, the location of the hematoma was well correlated with the grade of fourth ventric...
ular compression. Midline hematomas were associated with greater degrees of fourth ventricular compression.

Outcomes

Our series included patients referred for consideration for surgical treatment, and the high mortality rates observed reflect a referral bias. In our study, age per se did not affect the selection criteria of the protocol. Furthermore, for 30% of the patients who died, the cause of death was directly related to their poor general condition and concomitant systemic disease. There were relatively few patients with Grade I ventricular compression. Identification of factors that could facilitate prediction of the subsequent course at an early stage after presentation would affect the indications for surgery, which should be preventive. None of the patients with Grade III ventricular compression and GCS scores of less than 8 at the time of treatment survived with good outcomes. Our policy of attempting surgical treatment for patients in poor neurological and general condition explains the high mortality rates for surgically treated patients in our group.

CONCLUSIONS

Decision-making in the management of spontaneous cerebellar hematomas requires careful consideration and interpretation of the various criteria. The configuration of the fourth ventricle on CT scans is a useful sign for selection of the appropriate surgical procedure, compared with estimation of the size of the hematoma and/or evaluation of the quadrigeminal cistern.

The results of this series support the management protocol. The outcomes of patients with Grade III ventricular compression and GCS scores of less than 8 at the time of treatment were poor, despite aggressive treatment. Nonsurgical treatment may be undertaken for this group of patients; however, apart from absent brainstem reflexes, there are no identified criteria to exclude all of these patients from aggressive treatment. A more aggressive approach should be recommended for young patients. Aggressive early surgical evacuation of the hematoma and ventricular drainage for patients with Grade III ventricular compression, before deterioration of the consciousness level, is emphasized. Simply, our treatment protocol uses GCS scores to select patients for surgical treatment and uses the degree of fourth ventricular compression to select the surgical procedure.

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REFERENCES

Kirollos et al. describe a treatment protocol with which they managed 50 patients with spontaneous cerebellar hematoma. In contradistinction to previous studies that stratified patient treatment on the basis of volume or axial diameter of the cerebellar hematoma, these authors formulated a treatment algorithm based on the degree of fourth ventricular compression and the GCS score of the patient. The major decision-making strategy occurs in the authors’ Grade II patients, who
have some degree of fourth ventricular compression but not complete obliteration of the fourth ventricle. For their patients in Grade II with a high GCS score (>13), observation was the initial treatment rather than surgical evacuation. Theirs is an interesting protocol, and the study is well designed, well executed, and beautifully documented. I think the best thing we can say about their management of these Grade II patients is that they were successful because of their ability to closely observe patients for neurological deterioration. Intuitively, we would think that these patients are placed at risk by not undergoing emergent surgical evacuation. In point of fact, all of their patients who deteriorated in this group were ultimately salvaged by either ventricular drainage or surgical evacuation, except for one patient who died from a pulmonary embolus.

I have commented previously that evacuation of a cerebellar hematoma carries a low morbidity and, to my mind, is justifiable in almost any case in which a neurological deficit or impending neurological catastrophe is suspected. I think that the authors of this study had the ability to observe patients very closely and their successful clinical outcomes are to be credited to this strategy. I feel strongly, however, that, these results notwithstanding, patients with any hint of neurological compromise and cerebellar hematoma should undergo urgent surgical intervention (which represents simple surgery with an expected excellent outcome), as has been the classical teaching in neurosurgery for many years. Articles such as this, while they do represent a scientific study of the problem, do little to dissuade me from this instinctive reaction to a critical and life-threatening problem.

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The authors have prospectively applied a management protocol to 50 consecutive patients presenting with spontaneous cerebellar hemorrhage. A combination of clinical status, as determined by the GCS score and the degree of fourth ventricular compression, was used in the decision-making protocol. The authors found that surgical evacuation may not be required for hematomas greater than 3 cm in diameter, provided that the fourth ventricle is not completely obliterated, but that conscious patients with fourth ventricular obliteration should undergo urgent clot evacuation. They also noted that patients with partial obstruction of the fourth ventricle require careful observation and may also require surgical evacuation of the clot if ventricular drainage does not improve the clinical status or if the deterioration occurs in the absence of ventriculomegaly. The authors have provided a logical framework for the management of patients with cerebellar hemorrhage. Further studies with more patients may help to identify other factors that affect outcome, which may prove useful to incorporate into this straightforward scheme.

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