Impact of stereotactic hematoma evacuation on activities of daily living during the chronic period following spontaneous putaminal hemorrhage: a randomized study

NAOYUKI HATTORI, M.D., YOICHI KATAYAMA, M.D., PH.D., YOSHIKO MAYA, PH.D., AND ALEXANDER GATHERER, M.D.

Department of Neurological Surgery, Nihon University School of Medicine, Tokyo; Department of Social Insurance, Nihon University School of Commerce, Tokyo, Japan; and Medical Risk Management Center, Wolfson College, University of Oxford, United Kingdom

Object. Stereotactic evacuation of hematoma has been reported to reduce the incidence of mortality and to improve functional outcome in patients with spontaneous putaminal hemorrhage. Stereotactic evacuation of hematoma has not been widely accepted as a standard therapy, however, because its effect on functional outcome has been regarded as marginal and there have been no randomized trials with sufficient statistical power to quantify the benefits of this procedure. The authors reassessed the value of stereotactic evacuation of hematoma by analyzing its impact on activities of living during the chronic period following spontaneous putaminal hemorrhage in a randomized study.

Methods. Four hundred ninety patients were entered into the study. The severity of their hemorrhages was graded neurologically on admission (neurological grades: 1, eyes are open; 2, eyes are closed but open to weak stimuli; 3, eyes are closed but open to strong stimuli; 4, eyes do not open but extremities move to stimuli; and 5, eyes do not open and extremities do not move to stimuli). Patients with Grade 2 and those with Grade 3 were randomized into two groups with different treatment protocols (Group I, stereotactic evacuation of the hematoma; and Group II, conservative treatment). Patients assigned neurological Grade 4 or 5 were excluded from the study because a large-scale retrospective study in Japan revealed that surgical treatment in patients assigned to these neurological grades does not improve functional outcome. Among the 490 patients, 242 were randomized strictly. This patient population comprised 148 men and 94 women ranging in age from 38 to 80 years (mean 60.5 years).

Compared with Group II, Group I treatment resulted in a lower mortality rate and better recovery to functional independence in patients with neurological Grade 3. In patients with Grade 2, Group I treatment contributed to a better recovery of functional outcome and a lower mortality rate, but the difference was not significant. Multivariate analysis confirmed that stereotactic evacuation of the hematoma was contributory to a better recovery in functional outcome.

Conclusions. Stereotactic evacuation of hematoma is clearly of value in selected patients with spontaneous putaminal hemorrhage, whose eyes are closed but will open in response to strong stimuli (neurological Grade 3) on admission.

KEY WORDS • spontaneous putaminal hemorrhage • stereotactic evacuation of hematoma • randomized trial • multivariate analysis

S PONTANEOUS ICH produces serious neurological sequelae, which require long-term medical and social care, imposing heavy financial and mental burdens on patients and their families and causing an enormous loss to society. At present, there is no consensus on treatment of patients with ICH because to date there has been no randomized study demonstrating an improvement in functional outcome and mortality rates following surgical intervention compared with medical treatment. All previous trials were individually insufficient in their statistical power to be used reliably to quantify the risks and benefits of surgery.

Stereotactic evacuation of hematoma has been reported to reduce the incidence of mortality and improve functional outcomes in patients with spontaneous ICH, especially in those with hemorrhage within the putamen. Stereotactic evacuation of hematoma has not been widely accepted as a standard therapy for treating spontaneous ICH, however, because its effect on functional outcome has been regarded as marginal and there has been no randomized trial of this procedure. We therefore conducted our original randomized trial in patients with putaminal hemorrhage in an attempt to evaluate the effectiveness of stereotactic evacuation of hematoma.

Clinical Material and Methods

In this prospective study, we examined 490 patients in whom spontaneous putaminal hemorrhage was diagnosed on the basis of findings on CT scans. The patients were hospitalized at five hospitals affiliated with our department during the 3-year period between 1998 and 2000. The following inclusion criteria were used for the study: 1) patient age between 35 and 85 years; and 2) an interval between stroke and the start of treatment lasting less than 24 hours. The following exclusion criteria were included: 1) patients in whom hemorrhage spread into brain tumors or came from cerebral aneurysms or arteriovenous malformations; 2) patients with malignant neoplasms; and 3) patients with bleeding disorders or those receiving anticoagulant medications.
improves functional outcome and, even if patients survive, risk of mortality, but there is no evidence indicating that surgical treatment improves the neurological Grade 4 or 5, we selected each treatment protocol (Section 4a) or with [4b] signs of herniation; and Grade 5, eyes do not open but extremities move in response to stimuli without [4a] or [4b] signs of herniation. Findings on CT scans were categorized to the thalamus or subthalamus). The hematoma volume was expressed in cubic centimeters and derived using the formula $\pi \times width \times length \times height (cm^3)/6$, based on the length of the hematoma radius estimated on CT scans. Data from laboratory examinations of blood samples obtained on the day of hospital admission were also analyzed.

**Neurological Grading and CT Classification**

The severity of the neurological injury was defined on admission according to the neurological grades adopted by the Japanese Cooperative Study on Stroke Surgery (Grade 1, eyes are open; Grade 2, eyes are closed but open to weak stimuli; Grade 3, eyes are closed but open to strong stimuli; Grade 4, eyes do not open but extremities move in response to stimuli without [4a] or with [4b] signs of herniation; and Grade 5, eyes do not open and extremities do not move in response to stimuli). Findings on CT scans were categorized into five groups, regardless of whether there was intraventricular hemorrhage, according to the classification adopted by the Japanese Cooperative Study on Stroke Surgery (Grade I, localized in the putamen and outside the internal capsule; Grade II, extending to the anterior limb of the internal capsule; Grade III, extending to the posterior limb of the internal capsule; Grade IV, extending to the anterior and posterior limbs of the internal capsule; and Grade V, extending to the thalamus or subthalamus). The hematoma volume was expressed in cubic centimeters and derived using the formula $\pi \times width \times length \times height (cm^3)/6$, based on the length of the hematoma radius estimated on CT scans. Data from laboratory examinations of blood samples obtained on the day of hospital admission were also analyzed.

**Randomization of the Treatment Protocol**

Patients with neurological Grade 2 or 3 who fulfilled the inclusion criteria were admitted into the study. Randomization was accomplished using sealed, opaque envelopes with equal treatment allocation probabilities (Group I, stereotactic evacuation of the hematoma; Group II, conservative treatment). We explained to the patients and their families the purpose of the present study and informed them that there is no firm evidence to indicate that surgical treatment improves functional outcome. If any patient or family member requested a specific treatment protocol, the patient was excluded from the study. Patients with neurological Grade 1, 4, or 5 were excluded from the study. Patients with neurological Grade 1 were automatically allocated to conservative treatment because there has been no evidence to indicate that surgical treatment improves functional outcome in patients assigned this neurological grade. In patients with neurological Grade 4 or 5, we selected each treatment protocol according to the family’s requests after we had explained to the family that surgical treatment improves the risk of mortality, but there is no evidence indicating that it improves functional outcome and, even if patients survive, approximately 80% remain severely disabled or in a persistent vegetative state. Local ethical committees at each hospital approved the protocol used in this study.

**Evaluation of Outcome**

Neurological outcome was evaluated directly 1 year posthemorrhage by one of the authors (N.H.) who was blindfolded to the random allocation. The muscle power of the lower extremity contralateral to the side of hemorrhage was expressed according to the classification of the British Medical Research Council (muscle power scores: 1, a trace of contraction; 2, active movement with gravity eliminated; 3, active movement against gravity; 4, active movement against gravity and resistance; and 5, normal power). The ADL were scored by application of the modified Rankin Scale (scores: 0, no symptoms; 1, minor symptoms that do not interfere with lifestyle; 2, minor handicap that leads to some restriction in lifestyle, but does not interfere with the patients’ capacity to look after themselves; 3, moderate disability that significantly restricts lifestyle and prevents a totally independent existence; 4, moderately severe disability that clearly prevents an independent existence, although constant attention is not needed; 5, severe disability requiring constant attention night and day; 6, death). The scale was also collapsed into two categories: functional independence (Score 0, 1, or 2) and functional dependence (Score 3, 4, or 5).

**Statistical Analysis**

Mortality rates and recovery to functional independence were compared between Groups I and II by performing the chi-square test. Costs were compared between these groups by performing the unpaired Student t-test. Differences were regarded as significant if the probability value was less than 0.05. Multiple regression analysis was performed in 120 patients in whom detailed data for the explanatory variables were available. The Spearman correlation coefficient was initially calculated for 21 items including patient age, sex, neurological grading, CT findings, hematoma volume, muscle power, stereotactic evacuation of hematoma, previous cerebrovascular accident, and laboratory data as candidates for explanatory variables of the ADL. The explanatory variables for the multiple regression analysis were then selected. The correlation was regarded as significant if the probability value was less than 0.05.

**Results**

**Effects on ADL**

In total, 242 patients were randomized in the present study. There were 148 men and 94 women ranging in age from 38 to 80 years (mean 60.5 years). Among the 242 patients, 121 were surgically treated (Group I) and 121 were treated conservatively (Group II). There were no significant differences between these two groups with regard to age, sex, neurological grading, hematoma volume, muscle power, stereotactic evacuation of hematoma, previous cerebrovascular accident, and laboratory data as candidates for explanatory variables of the ADL. The explanatory variables for the multiple regression analysis were then selected. The correlation was regarded as significant if the probability value was less than 0.05.
Effectiveness of stereotactic hematoma evacuation

### TABLE 2

<table>
<thead>
<tr>
<th>Neurological Grade &amp; Treatment</th>
<th>No. of Patients</th>
<th>Mortality Rate (%)</th>
<th>Functional Outcome (% patients)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Independent</td>
<td>Dependent</td>
</tr>
<tr>
<td>Grade 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>70</td>
<td>4.3</td>
<td>52.9</td>
</tr>
<tr>
<td>Group II</td>
<td>70</td>
<td>11.4</td>
<td>40.0</td>
</tr>
<tr>
<td>Grade 3</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Group I</td>
<td>51</td>
<td>11.8</td>
<td>47.1</td>
</tr>
<tr>
<td>Group II</td>
<td>51</td>
<td>23.5</td>
<td>21.6</td>
</tr>
</tbody>
</table>

* p < 0.05 compared with Group II according to the chi-square test.

### Discussion

Spontaneous ICH is a devastating condition for both patients and their families. At present, there is no consensus regarding whether surgical therapy produces a better outcome than other alternatives. Several studies involving randomized trials have failed to demonstrate any improvement in morbidity and mortality rates after evacuation of the hematoma by craniotomy in patients with spontaneous ICH.3,17,22,23 McKissock, et al.22 reported the first randomized trial in 1961 in which 180 patients were included. This investigation was conducted during the pre–microneurosurgical and pre–CT era. In studies reported by Juvela,17 Batjer,1 Morgenstern,24 and their colleagues, the numbers of patients (≤ 52 patients) were too small to come to any firm conclusion. Three recent metaanalyses (≤ 249 patients) of published trials of craniotomy for ICH were found to be inconclusive, indicating that more information is needed from randomized studies to determine the role of surgical evacuation of hematomas.13,26,33 On the other hand, a large-scale retrospective study (7010 patients) in Japan has revealed an improvement in mortality and morbidity rates following hematoma evacuation by craniotomy.34

Many investigators have reported the effectiveness of stereotactic evacuation of hematoma. The advantages of this technique are that it can be performed after administration of local anesthesia and it is minimally invasive.6,14,16,21,25,26 Still, there has been no randomized study on the procedure. In one retrospective investigation the authors indicated no significant difference in mortality and morbidity rates between stereotactic evacuation of hematoma and conservative treatment,38 but the number of patients examined (≤ 40 patients) was too small to come to a firm conclusion. Kandel and Peresedov20 and Tanahashi, et al.,34 found that the procedure only improved the mortality rate in patients with severe hemorrhage, similar to the results of craniotomy. In the study reported by Kandel and Peresedov the severity of the neurological injury was stratified into only two groups. In the study reported by Tanahashi, et al., there was a relatively small number of patients with mild and moderate hemorrhage (43 patients who underwent stereotactic evacuation of a hematoma (≤ 1023; p < 0.013) and a higher cholinesterase level (≤ 1.423; p < 0.015) were found to contribute to a better ADL score (Table 3). A comparison of actual and estimated values revealed that 108 (90%) of 120 analyzed cases registered a relative difference that was less than 1.3,9,10,11,13,18,40

### Conclusions

The results of the present randomized study confirmed the benefits of stereotactic evacuation of hematoma for reducing the incidence of mortality and improving functional outcome in spontaneous putaminal hemorrhage. Stereotactic evacuation of a hematoma reduced the mortality rate and improved functional outcomes in patients with neurologically Grade 3. Multivariate analysis also confirmed that stereotactic evacuation of hematoma contributed to improving the ADL.
Stereotactic hematoma evacuation is clearly of value from the medical point of view in selected patients with spontaneous putaminal hemorrhage whose eyes are closed but will open in response to strong stimuli (neurological Grade 3) on admission.

References


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Address reprint requests to: Naoyuki Hattori, M.D., Department of Neurological Surgery, Nihon University School of Medicine, Tokyo 173-8610, Japan. email: ykatayama@med.nihon-u.ac.jp.