Involvement of Fluctuating High Blood Pressure in the Enlargement of Spontaneous Intracerebral Hematoma

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Abstract

The correlations between changes in blood pressure after admission and hematoma expansion were investigated in 118 patients with spontaneous intracerebral hematoma admitted within 24 hours of onset who underwent serial computed tomography. Multiple logistic regression was performed to assess correlations between hematoma enlargement and clinical characteristics on admission. Hematoma enlargement was predominantly correlated with time of onset (p = 0.01567), and not well correlated with blood pressure at admission (p = 0.07908). Serial changes in blood pressure were investigated in 57 patients admitted within 6 hours of ictus whose blood pressures were monitored every hour from admission. Wilcoxon signed-rank analysis was used to determine the relationships between hematoma enlargement and blood pressure. Patients with hematoma enlargement was significantly correlated with increased blood pressure (p = 0.0004). Increases in blood pressure after admission may be a factor in hematoma enlargement.

Key words: spontaneous intracerebral hemorrhage, enlargement, blood pressure

Introduction

Spontaneous intracerebral hematoma (ICH) frequently enlarges during the acute stage after hospital admission.1-5,10,14,16,17 The most important predictor of rapid hematoma expansion is the time after the ictus, followed by liver dysfunction, low serum fibrinogen level, and hematoma shape.2,5,6,9,16

Clinical control of blood pressure is important in patients with ICH, because high blood pressure enhances and aggravates bleeding. High blood pressure, especially systole over 200 mmHg, increases the occurrence and incidence of hematoma growth,8 but blood pressure at admission is not correlated with hematoma enlargement.5,12,16 However, blood pressure is a changeable factor that should be evaluated periodically. This study reviewed the medical records of the patients with ICH to investigate any relationship between hematoma enlargement and changes in blood pressure.

Subjects and Methods

We reviewed the records of patients with ICH admitted to Chugoku Rousai Hospital between January 1984 to December 1992. Patients with a history of hypertension were included, but patients with vascular malformation, aneurysm, tumor, trauma, or any disease causing hemostatic imbalance were excluded. A total of 509 patients with ICH were selected (Table 1). To investigate the incidence of rapid hematoma expansion, we excluded patients admitted 24 hours or later after the onset. Serial computed tomography (CT) was performed in 299 patients who did not undergo invasive procedures during these examinations. The other patients were not followed by CT because of emergency surgery, poor physical health, or stressful invasive procedures such as angiography.
Table 1  Summary of patients with intracerebral hematoma

<table>
<thead>
<tr>
<th>Site of hematoma</th>
<th>Interval from onset to admission</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;24 hrs Serial CT (+) / Serial CT (−) ≥24 hrs</td>
<td></td>
</tr>
<tr>
<td>Putamen</td>
<td>124 / 14 / 210</td>
<td></td>
</tr>
<tr>
<td>Thalamus</td>
<td>84 / 27 / 130</td>
<td></td>
</tr>
<tr>
<td>Caudate nucleus</td>
<td>5 / 7 / 13</td>
<td></td>
</tr>
<tr>
<td>Subcortex</td>
<td>51 / 15 / 73</td>
<td></td>
</tr>
<tr>
<td>Cerebellum</td>
<td>16 / 17 / 37</td>
<td></td>
</tr>
<tr>
<td>Brainstem</td>
<td>19 / 15 / 46</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>299 / 153 / 57 / 509</td>
<td></td>
</tr>
</tbody>
</table>

CT: computed tomography.

I. Risk factors for hematoma enlargement

Serial CT was used to detect ICH enlargement. The clinical characteristics were compared in patients with and without enlargement of the ICH on repeated CT. Enlargement occurred only in the putamen and thalamus, so clinical characteristics were compared only in patients with putaminal and thalamic hemorrhage. Patients without exact information about the time of onset or blood pressure on arrival were excluded. The time of onset was recorded in intervals of 30 minutes. Finally, 28 patients with enlarged ICH, 22 in the putamen and six in the thalamus, and 90 patients with ICH without enlargement, 66 in the putamen and 24 in the thalamus, were included (Table 2). Initial CT was performed at 4.1 ± 3.8 hours (range 0.5–18.0 hrs), and repeat CT at 25.1 ± 19.6 hours (range 3.0–72.0 hrs).

Multiple logistic regressions used increase (=1) and no increase (=0) as intentional variables, and age, sex, time after onset, blood pressure on admission, and past medical histories (liver dysfunction, diabetes mellitus) as explanatory variables. Preliminary analysis investigated the correlations with the explanatory variables using computer software (Statistica 5.1; StatSoft, Inc., Tulsa, Okla., U.S.A.).

II. Effect of blood pressure change after admission

Patients admitted within 6 hours of onset whose blood pressures were monitored every hour for 6 hours were selected. There were 19 patients with hematoma enlargement (17 in the putamen, 2 in the thalamus), and 38 without enlargement (31 in the putamen, 7 in the thalamus). Patients were classified into five groups depending on their systolic blood pressure in the 6 hours after admission: Group A, systolic blood pressure below 140 mmHg; Group B, below 160 mmHg; Group C, below 180 mmHg; Group D, below 200 mmHg; and Group E, over 200 mmHg. Wilcoxon signed-rank analysis was performed to analyze the correlation between hematoma enlargement and blood pressure after admission.

Results

I. Risk factors for hematoma enlargement

Preliminary analysis of each variable showed a relationship between age and past medical history, so age was excluded from the explanatory variables. Blood pressure on admission, time after onset, and sex showed no correlations. Results of multiple logistic regressions are shown in Tables 2 and 3. Patients with increased blood pressure on admission tended to develop hematoma enlargement. Time after onset was significantly correlated with hematoma enlargement (p = 0.011567). The correlations between hematoma enlargement and blood pressure on admission, and time after onset are shown in Fig. 1. Most patients with enlarged hematoma were admitted within 6 hours of onset. Only one patient was admitted at 9 hours after onset. All patients
Fig. 1 Relationships between time after onset, blood pressure, and rapid expansion of hematoma, showing the high incidence of expansion in patients admitted in the acute period. Patients with rapidly expanding hematoma arrived within 6 hours of the ictus except for one. Patients with systolic blood pressures below 140 mmHg did not show hematoma enlargement. ○: hematoma enlargement (−), ●: hematoma enlargement (+).

with blood pressure below 140 mmHg demonstrated no enlargement. Only 10 of 22 patients with putaminal hematoma and three of six patients with thalamic hematoma showed neurological deterioration at the time of repeat CT. Therefore, half of the patients suffered no neurological deterioration despite hematoma expansion. Seventeen patients with expanding putaminal hematoma underwent surgery (evacuation in 10 and aspiration in 7). Four patients with thalamic hematoma underwent aspiration surgery.

II. Effect of blood pressure change after admission

Serial blood pressure changes in each patient are shown in Fig. 2. Blood pressures were comparatively stable in patients without enlargement. However, blood pressure was unstable in patients with enlargement, and paroxysmal high blood pressure was often seen. The patients were classified into the five groups according to their blood pressure during the first 6 hours on admission (Table 4). The rapidly expanding ICH group included more patients in Groups D and E, and the non-expanding ICH group had more patients in Groups A and B. Persistent hypertension after admission was associated with enlargement of the hematoma (p = 0.0004, Wilcoxon signed-rank test).

Table 4 Systolic arterial blood pressure (SABP) changes after admission within 6 hours of hemorrhage

<table>
<thead>
<tr>
<th>Group (SABP, mmHg)</th>
<th>Patients with rapidly enlarging hematoma (n = 19)</th>
<th>Patients with no enlargement of hematoma (n = 38)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (≤ 140)</td>
<td>2 (10.5%)</td>
<td>8 (21.5%)</td>
</tr>
<tr>
<td>B (&gt; 140–160)</td>
<td>2 (10.5%)</td>
<td>19 (50.0%)</td>
</tr>
<tr>
<td>C (&gt; 160–180)</td>
<td>6 (31.6%)</td>
<td>8 (21.1%)</td>
</tr>
<tr>
<td>D (&gt; 180–200)</td>
<td>6 (31.6%)</td>
<td>3 (7.9%)</td>
</tr>
<tr>
<td>E (&gt; 200)</td>
<td>3 (15.8%)</td>
<td>0</td>
</tr>
</tbody>
</table>

Discussion

I. Incidence of hematoma enlargement

Rapid expansion of ICH in the putamen or thalamus occurs in 3–6% of patients.4,17) Previous data were analyzed without specific statistical methodology, but some recent reports utilized exact statistical analysis.2,5,7) ICH enlarged in the acute phase in 26% of cases, and thus is not a rare phenomenon.2) We analyzed only patients who underwent serial CT, and showed that the rate of hematoma expansion was 10.4% (31/299) in all cases of ICH, 19.4% (24/124) in cases of putaminal hematoma, and 8.3% (7/84) in cases of thalamic hematoma. Therefore, our results also indicate that hematoma enlargement in the acute period is not rare. Our study excluded both patients without serial CT and patients who underwent emergency surgery. The occurrence of rapid hematoma expansion in these patients is unknown in this large group.

II. Risk factors for hematoma enlargement

Hematoma enlargement is considered to result from continued bleeding. The source of continuous bleeding may be a single artery2) or multiple vessels surrounding the hematoma.11) Demonstration of extravasation by cerebral angiography15) and contrast enhancement on CT11) reflect active bleeding from these sites. The time after onset and blood pressure are common factors responsible for spontaneous hemostasis. Multiple regression analysis indicates that the time after onset is the common factor for rapid hematoma enlargement.5,9) In our series, CT detected all 28 cases of rapid hematoma expansion.
Enlargement of ICH

Fig. 2 Serial changes in blood pressure after admission.Patients without enlargement (left) showed relatively stable blood pressures. Patients with enlargement (right) showed unstable blood pressure, and often demonstrated paroxysmal high blood pressure.

within 5 hours of onset. Our multiple logistic regression analysis also demonstrated the most important predisposing factor was the time after onset ($p = 0.011567$). Active bleeding was not associated with neurological deterioration in one of four patients.$^1$ In our series, half of the patients with hematoma enlargement did not suffer neurological deterioration. We recommend serial CT for patients arriving within 6 hours of the onset regardless of whether neurological deterioration is detected.

The involvement of hypertension in hematoma expansion is still under debate.$^5,12,13,16$ However, patients with poorly controlled diabetes and high systolic blood pressure are at high risk of hematoma enlargement.$^9$ Recent investigations found no significant influence of blood pressure on admission on hematoma enlargement. In our study, high arterial blood pressure might affect hematoma expansion, but the correlation was only marginally higher than that with non-expanding ICH ($p = 0.07162$). We thought that the effect of blood pressure could not be assessed by only the comparison of the two groups. The blood pressures of both groups were higher than those of healthy persons. All patients with normal systolic blood pressure (below 140 mmHg) demonstrated no changes in hematoma.

III. Effect of blood pressure change after admission

Patients with hematoma enlargement had increased blood pressure after admission (Table 4). Our results show that an increase in blood pressure was correlated with hematoma enlargement. This retrospective study cannot determine whether hematoma expansion causes increased blood pressure or whether high blood pressure causes hematoma expansion, or whether increased blood pressure is an epiphenomenon of a third factor. However, our study indicates that blood pressure after admission must be monitored, and should be considered as a possible predictor or sign of hematoma enlargement.

Recent reports have denied any correlation between blood pressure on admission and hematoma expansion.$^5,12,16$ However, the correlation between serial changes of blood pressure and hematoma expansion is less clear. We must take care to monitor blood pressure and to identify hematoma expansion as early as possible. Whether blood pressure control is beneficial for preventing hematoma enlargement is unknown. The only way to definitively answer this question is to perform a controlled trial.

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References


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Commentary

Maruishi et al. investigated serial changes in blood pressure in 57 patients admitted within 6 hours of spontaneous intracerebral (putamen and thalamus) hemorrhage and concluded that hematoma enlargement was significantly correlated with increased blood pressure. They also found that blood pressure was comparatively stable in patients without hematoma enlargement, but was unstable, with frequent occurrence of paroxysmal hypertension, in patients with hematoma enlargement.

Expansion of hypertensive intracerebral hemorrhage associated with elevated blood pressure is often seen in patients during the acute phase of the ictus. Therefore, it has been mandatory to monitor blood pressure and control of blood pressure as a possible means of preventing this devastating complication.

As the authors pointed out, this retrospective study could not determine whether hematoma expansion caused increased blood pressure or whether high blood pressure caused hematoma expansion. However, the authors are to be commended for their invaluable work that is the drawing attention of practicing neurosurgeons.

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Maruishi et al. present a retrospective series of patients with intracerebral hematoma (ICH), in which ICH enlargement and fluctuating high blood pressure (BP) after admission can be related. They reviewed the routine CT scans trying to evaluate ICH enlargement after admission. How such enlargement (volume, maximal diameter, computer volumetric determination, mass effect, etc.) was evaluated is not clearly specified, which may be of concern for the proper interpretation and reproduction of the results. The BP after admission was evaluated and registered as isolated measures each hour for 6 hours, this is an
important issue because BP is quite variable during the day, and an isolated measure is unreliable to evaluate the BP pattern, and a Holter study of BP can improve the assessment of this variable. They found that half of the patients with ICH enlargement did not suffer neurological deterioration, so they recommend serial CT regardless of whether neurological deterioration is detected. We disagree because any hematoma expansion in a neurologically stable patient does not change the management strategy. This study is an attempt to determine the possible factors involved in ICH enlargement and its management. We think that a controlled prospective trial, with continuous monitoring of BP, can better elucidate the eventual factors of enlargement and the proper management of this pathology.

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Maruishi and colleagues retrospectively analyzed patients with hematoma enlargement after admission in comparison with those without. The authors demonstrated a relationship between such enlargement and shorter time from symptom onset and increased systolic blood pressure measured hourly for 6 hours after admission. The relationship seems to be natural, although rarely described in multivariate statistical analysis. Hematoma enlargement is thought to result in poor outcome, but the outcome of the patients was not discussed in this study. Interestingly, some patients did not show any worsening even though hematoma increased. Did they already have severe hemiparesis before hematoma enlargement? How did the enlargement influence the surgical indication? Details of the clinical feature should be documented, since the authors emphasize the relevance of repeated CT evaluation even when patients show no deterioration.

Blood pressure on admission was not well correlated with the enlargement. Admission blood pressure was not constantly associated with poor prognosis in several studies. Time course of blood pressure after admission seems to be more valuable as shown in this study. Fogelholm et al. employed the highest mean blood pressure in the first 24 hours from onset as a predictor of poor outcome, instead of blood pressure on admission.21 It is uncertain whether hematoma expansion causes increased blood pressure or increased blood pressure causes hematoma enlargement. Becker et al. indicated that nearly half of the patients with intracerebral hematoma showed extravasation of contrast medium at the time of CT angiography, and such a phenomenon was one of the predictors of poor prognosis. Increased blood pressure, GOS score and hematoma size were independently associated with the extravasation.1

References


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Maruishi et al. well describe the importance of control of systemic blood pressure after ictus to prevent enlargement of intracerebral hematoma (ICH) using a statistical analysis of their own experience. The size of ICH that can enlarge after ictus is one of the important factors to determine the clinical symptoms and prognosis of ICH. The authors describe twenty-eight patients among 118 patients with ICH who showed hematoma enlargement, and half of these patients showed worsening of their clinical symptoms. Therefore, it is important to prevent enlargement of ICH after ictus. Focusing on the changing blood pressure after ictus, the authors clarified the relationship between increased blood pressure and hematoma enlargement using serial CT scans and systemic blood pressure recording. The conclusion of this paper is clinically significant, and contributes to the improvement of the outcome of ICH.

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