Right Sylvian Fissure Subarachnoid Hemorrhage Has Electrocardiographic Consequences

Yutaka Hirashima, MD; Shutaro Takashima, MD; Nobuhisa Matsumura, MD; Masanori Kurimoto, MD; Hideki Origasa, PhD; Shunro Endo, MD

Background and Purpose—Abnormal ECG changes are frequently observed in patients with subarachnoid hemorrhage (SAH). Recently, evidence has been obtained that right insular cortex mediates sympathetic cardiovascular effects. We therefore assessed the laterality and location of SAH dominance in inducing cardiovascular changes as measured by ECG, blood pressure, and heart rate.

Methods—After exclusion of 11 SAH patients who died within 1 month after onset, we studied 118 consecutive patients. Data were obtained from records of blood pressure and pulse on admission. Abnormal ECG changes were determined from ECGs on admission and almost 1 month later. From brain CT scans performed immediately after admission, the amount of SAH in each of the 8 cisterns and fissures was measured semiquantitatively.

Results—Twenty-six patients had abnormal changes on admission ECG, while 92 patients did not. Systolic blood pressure, diastolic blood pressure, and the amounts of blood in the left ambient cistern, left suprasellar cistern, quadrigeminal cistern, right ambient cistern, right suprasellar cistern, right sylvian fissure, and the set of all cisterns were significantly greater in the group with ECG change than in the group without ECG change. Multivariate logistic regression analysis with stepwise method indicated that systolic blood pressure >160 mm Hg (P=0.0006) and the amounts of SAH in the quadrigeminal cistern (P=0.022) and right sylvian fissure (P=0.0019) were independently associated with abnormal ECG change.

Conclusions—Cardiac consequences are possible in patients with massive right sylvian fissure SAH or when systolic blood pressure is >160 mm Hg. (Stroke. 2001;32:2278-2281.)

Key Words: cerebral cortex ■ electrocardiography ■ laterality ■ subarachnoid hemorrhage

Abnormalities of the ECG, chiefly repolarization changes including T-wave inversion, QT prolongation, and ST-segment elevation or depression, have been reported after stroke. These changes are most commonly reported after subarachnoid hemorrhage (SAH). It has been shown that such changes are a more frequent consequence of hemispheric than of brain stem lesions. Furthermore, results of intraoperative insular cortex stimulation suggest right-sided insular dominance in mediation of sympathetic cardiovascular effects. We therefore assessed the laterality and location of SAH dominance in inducing cardiovascular effects as measured by ECG, blood pressure, and heart rate.

Subjects and Methods

Study Population

With exclusion of 11 patients for whom follow-up ECG was not performed because of early death after admission, we studied 118 consecutive patients who suffered SAH and were admitted within 24 hours after onset of SAH to the Toyama Medical and Pharmaceutical University Hospital between June 1995 and October 1999. The clinical data for these 118 patients with SAH are summarized in Table 1. Clinical condition on admission was evaluated according to the Hunt and Hess classification and the Glasgow Coma Scale. The severity of SAH was assessed according to Fisher’s classification.

Data Collection

On admission, ECG and blood pressure measurement were performed for routine monitoring. Brain CT scan was performed immediately after admission. A Toshiba TCT-900S device, which displayed pictures on a 512×512 matrix, was used. The amounts of subarachnoid blood in 10 cisterns or fissures, namely, the interhemispheric fissure, right and left lateral sylvian fissures, right and left basal sylvian fissures, right and left suprasellar cisterns, right and left ambient cisterns, and quadrigeminal cistern, on CT were evaluated semiquantitatively as scores ranging from 0 to 3 according to the criteria of Hijdra et al. Each cistern or fissure was graded separately according to the amount of extravasated blood: 0, no blood; 1, small amount of blood; 2, moderately filled with blood; or 3, completely filled with blood. We modified the method of Hijdra et al. The average of scores of basal and lateral sylvian fissures was defined as the score of sylvian fissure, right sylvian fissure, or left sylvian fissure. Total amount of SAH was also calculated. Three authors of this report independently and blindly scored all of the CT scans.
performed on admission 2 times and averaged them. A cardiologist evaluated changes in ECG between admission and almost 1 month after onset. He determined ECG changes to be present on admission when T-wave inversion, QT prolongation, or ST-segment elevation or depression was detected and these findings disappeared on subsequent ECG.

**Statistical Analyses**

We performed all analyses using SPSS statistical software (SPSS version 8.01J, SPSS Inc). Comparisons of demographic data and clinical variations between groups with and without abnormal ECG changes were performed by Student’s t test, χ^2 test, and Mann-Whitney test. Variables were then entered in a stepwise logistic regression model to determine the independent effect of each variable on ECG change on admission. The correlation among 3 authors who scored SAH or that between the first scoring and the second scoring in each author was determined from Spearman rank correlation coefficients. Values of *P*<0.05 were considered significant.

**Results**

Twenty-six patients had changes on admission ECG [ECG(+) group], while 92 patients did not [ECG(−) group] (Table 1). The ECG(+) group included more cases that were severe as determined by the Hunt and Hess classification and Fisher’s classification than the ECG(−) group (Table 1).

Furthermore, 5 of 26 patients (19.2%) with ECG abnormality on admission had previous history of cardiac disease and arrhythmia such as cardiomegaly, angina pectoris, and atrial fibrillation, while 6 of 92 patients (6.5%) without ECG abnormality had history of cardiac disease and arrhythmia. The history of cardiac disease and arrhythmia was more frequent in the former group than the latter group (*P*<0.001, χ^2 test). Other demographic data such as Glasgow Coma Scale score and location of ruptured aneurysm for these patients are also summarized in Table 1.

The correlation coefficients for the sum scores among the 3 authors who scored SAH were high (pair A-B, 0.92 [*P*<0.01] and 0.90 [*P*<0.01]; pair A-C, 0.94 [*P*<0.01] and 0.89 [*P*<0.01]; and pair B-C, 0.95 [*P*<0.001] and 0.90 [*P*<0.01]; Spearman rank correlation coefficients), and those between the first scoring and the second scoring in 3 authors were also high (A, 0.95 [*P*<0.01]; B, 0.93 [*P*<0.01]; and C, 0.93 [*P*<0.01]; Spearman rank correlation coefficients). We defined the mean value of 3 scores as the score for each cistern or fissure.
TABLE 2. Univariate Analysis of Factors Related to ECG Change

<table>
<thead>
<tr>
<th></th>
<th>ECG(+) (n=26)</th>
<th>ECG(-) (n=92)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP</td>
<td>176±23.8</td>
<td>144±23.6</td>
<td>&lt;0.0001†</td>
</tr>
<tr>
<td>DBP</td>
<td>91.0±9.54</td>
<td>78.0±14.0</td>
<td>&lt;0.0001†</td>
</tr>
<tr>
<td>HR</td>
<td>81.9±15.2</td>
<td>76.2±11.8</td>
<td>0.084†</td>
</tr>
<tr>
<td>SAH score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interhemispheric fissure</td>
<td>1.54±0.812</td>
<td>1.22±0.912</td>
<td>0.090‡</td>
</tr>
<tr>
<td>Left ambient cistern</td>
<td>1.54±0.812</td>
<td>1.05±0.830</td>
<td>0.011‡</td>
</tr>
<tr>
<td>Left suprasellar cistern</td>
<td>2.00±0.800</td>
<td>1.33±0.939</td>
<td>0.001‡</td>
</tr>
<tr>
<td>Left sylvian fissure</td>
<td>1.83±0.76</td>
<td>1.51±1.04</td>
<td>0.145‡</td>
</tr>
<tr>
<td>Quadrigeminal cistern</td>
<td>0.65±0.102</td>
<td>0.283±0.561</td>
<td>0.016‡</td>
</tr>
<tr>
<td>Right ambient cistern</td>
<td>1.62±0.941</td>
<td>1.12±0.876</td>
<td>0.021‡</td>
</tr>
<tr>
<td>Right suprasellar cistern</td>
<td>2.04±0.824</td>
<td>1.33±0.951</td>
<td>&lt;0.0001‡</td>
</tr>
<tr>
<td>Right sylvian fissure</td>
<td>2.23±0.73</td>
<td>1.30±0.87</td>
<td>&lt;0.0001‡</td>
</tr>
<tr>
<td>Total*</td>
<td>17.5±4.62</td>
<td>11.9±6.60</td>
<td>&lt;0.0001†</td>
</tr>
</tbody>
</table>

Values are mean±SD. *Sum of SAH scores for all fissures and cisterns. † t test. ‡ Mann-Whitney test.

TABLE 3. Multivariate Logistic Regression Analysis of Factors Related to ECG Change

<table>
<thead>
<tr>
<th></th>
<th>Adjusted Odds Ratio</th>
<th>95% CI</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>SBP (&gt;160 mm Hg)</td>
<td>6.50</td>
<td>2.22–19.0</td>
<td>0.0006</td>
</tr>
<tr>
<td>SAH score</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quadrigeminal cistern &gt;2</td>
<td>7.26</td>
<td>1.32–39.8</td>
<td>0.022</td>
</tr>
<tr>
<td>Right sylvian fissure &gt;2</td>
<td>6.95</td>
<td>2.04–23.6</td>
<td>0.0019</td>
</tr>
</tbody>
</table>

right ambient cistern >2, right suprasellar cistern >2, right sylvian fissure >2, and total amount of SAH >16. Among these variables, SBP >160 mm Hg (odds ratio, 6.50; 95% CI, 2.22 to 19.0), quadrigeminal cistern >2 (odds ratio, 7.26; 95% CI, 1.32 to 39.8), and right sylvian fissure >2 (odds ratio, 6.95; 95% CI, 2.04 to 23.6) were independently associated with ECG change (Table 3).

Discussion

Brain stem cardiovascular regulatory centers affect cardiac function via sympathetic and parasympathetic efferents. However, HR and ECG changes also occur with suprabulbar lesions such as intracranial tumors, cerebral trauma, encephalitis, and stroke, including intracerebral hematoma, cerebral infarction, and SAH. In addition, changes in cardiac function can be psychologically induced. Although the mechanism underlying these changes remains unclear, it is suggested that supratentorial centers may be involved in cardiovascular regulation.

Patients with right-sided hemispheric brain infarction show a significantly reduced circadian blood pressure variability and a higher frequency of nocturnal blood pressure increase compared with patients with left-sided infarction. Right-sided infarction is also associated with higher serum norepinephrine concentration, and ECG more frequently shows abnormality such as QT prolongation and arrhythmia. HR decreases after right cerebral hemisphere inactivation by intracarotid amobarbital injection but increases after left hemisphere inactivation. These data suggest that there are differential cerebral effects on autonomic function that depend on the side of the cerebrum.

Results of human insular cortex stimulation suggest right-sided dominance in sympathetic cardiovascular effects and left-sided dominance in parasympathetic effects. In addition, animal experimentation using a rat model with middle cerebral artery occlusion, which results in a consistent lesion of brain including the insular cortex, directly addresses the role of lateralization of brain hemisphere, the site of cerebral infarction, and the effect of age on the ECG perturbations that develop after stroke. Therefore, the insular cortex is thought to be one of the most important sites of control of autonomic function. SAH blood in the Sylvian fissure possibly stimulates insular cortex mechanically and chemically and induces sympathetic cardiovascular effects such as ECG changes and blood pressure elevation. Our observations also support the hypothesis of differential left/right cerebral effects on autonomic function.

The most important consequence of cardiovascular effects due to SAH is increased susceptibility to sudden death.
Physicians must be aware of possible cardiac consequences in patients with massive SAH, especially in right sylvian fissure SAH or when systolic blood pressure is >160 mm Hg.

Acknowledgment
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References
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