Poststroke Depression Correlates With Cognitive Impairment and Neurological Deficits

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Background and Purpose—The prevalence of poststroke depression is known to be high, but the knowledge of its neuropsychological correlates is limited. This 12-month prospective study was designed to evaluate the natural history of poststroke depression and to study its neuropsychological, clinical, and functional associates.

Methods—We studied a series of 106 consecutive patients (46 women and 60 men, mean age 65.8 years) with acute first-ever ischemic stroke. The patients underwent a neurological, psychiatric, and neuropsychological examination at 3 and 12 months after the stroke. The psychiatric diagnosis of depression was based on DSM-III-R-criteria.

Results—Depression was diagnosed in 53% of the patients at 3 months and in 42% of the patients at 12 months after the stroke. The prevalence of major depression was 9% at 3 months and 16% at 12 months. There was an association between poststroke depression and cognitive impairment; the domains most likely to be defective in stroke-related depression were memory (P=0.022), nonverbal problem solving (P=0.039), and attention and psychomotor speed (P=0.020). The presence of dysphasia increased the risk of major depression. The depressive patients were more dependent in ADL and had more severe impairment and handicap than the nondepressive patients.

Conclusions—More than half of the patients suffer from depression after stroke, and the frequency of major depression seems to increase during the first year. In addition to dysphasia, poststroke depression is correlated with other cognitive deficits. We emphasize the importance of psychiatric evaluation of stroke patients. (Stroke. 1999;30:1875-1880.)

Key Words: cerebral infarction • cognition • depression • neuropsychological tests

Stroke is the leading cause of disability in adults, and it is often associated with mood disorders. The reported prevalence of poststroke depression varies from 20% to 65%, depending on the selection of the patients, diagnostic criteria, and the time elapsed after stroke. Poststroke depression is known to be related to dependence in activities of daily living (ADL) and to the severity of neurological deficits, but the present knowledge concerning the associations between cognitive deficits and depression is contradictory.

Many of the earlier reports have been criticized for the selection of the study population. The patient sample has often been small, and patients with dysphasia or comprehensive deficits have usually been excluded. In many studies the diagnosis of depression has been based on self-report inventories, which may produce unreliable results due to the patients’ verbal and cognitive deficits, and the diagnosis of the cognitive impairment has been based primarily on the Mini-Mental State Examination (MMSE) rather than on a thorough neuropsychological assessment. Therefore, multidimensional approaches to the changes in mood and cognitive ability as a consequence of stroke are clearly needed.

The aim of the present study was to evaluate the natural history of poststroke depression and to study its clinical, functional, and neuropsychological correlates. The patients underwent neurological, neuropsychological, and psychiatric evaluations at 3 and 12 months after stroke.

Subjects and Methods

One hundred six consecutive patients (46 women and 60 men, mean ± SD age 65.8±11.9 years, range 19 to 82 years) with first-ever brain infarction admitted to the Stroke Unit of the University Hospital were included in the study. Twenty-nine of the patients had been previously healthy, 46 patients had hypertension, 38 coronary heart disease, and 21 diabetes mellitus. Patients with TIA as well as patients with previous psychiatric illnesses or central nervous system disorders and alcoholism were excluded.

Eighty-eight (83%) of the patients had neurological deficits clearly attributable to a hemispheric brain infarction located in the internal carotid artery territory, 53 (60%) in the dominant and 35 (40%) in the nondominant hemisphere. Seventeen (16%) of the patients had clinical signs of brain stem infarction and 1 signs of cerebellar infarction. CT or MRI of the brain was performed on all the patients on admission to the hospital and visualized actual brain infarct pathology in 74 (70%) of the patients. A hemispheric infarct was verified by CT or MRI in 63 of the patients, with 34 of the infarcts...
The patients were clinically examined at 1 to 7 (median 3) days after the onset of symptoms and at 3 months and 12 months after the stroke. Patients’ impairments were assessed by use of the Scandinavian Stroke Scale (SSS) and its performance in ADL with the Barthel Index. The degree of handicap was scored with the Rankin Scale and the severity of intellectual deterioration with the MMSE. The test battery included standardized conditions. Parallel test versions were used when 3-month and 12-month follow-up visits with the same test battery in interviews.

When appropriate, eg, in dysphasic patients, additional information time of the day, by the same psychiatrist (P.H.), who was experienced with dysthymic disorders, ignoring the 2-year criterion of DSM-III-R.

<table>
<thead>
<tr>
<th>Test</th>
<th>Acute Phase</th>
<th>3 Months</th>
<th>12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>SSS (max. 58)</td>
<td>45 (6–58)</td>
<td>54 (18–58)</td>
<td>56 (26–58)</td>
</tr>
<tr>
<td>Barthel Index (max. 100)</td>
<td>68 (0–100)</td>
<td>100 (20–100)</td>
<td>100 (30–100)</td>
</tr>
<tr>
<td>MMSE* (max. 30)</td>
<td>26 (16–30)</td>
<td>27 (16–30)</td>
<td>28 (15–30)</td>
</tr>
<tr>
<td>Rankin Scale (max. 5)</td>
<td>4 (1–5)</td>
<td>2 (1–5)</td>
<td>2 (1–4)</td>
</tr>
</tbody>
</table>

Values are given as median (range). Max. 5 indicates the poorest performance.

*Test could not be carried out in 34 patients in the acute phase, in 19 patients at 3 months, and in 14 patients at 12 months after stroke because of severe deficits.

cortical and 29 subcortical; brain stem infarction was verified in 10 cases and cerebellar infarction in 1 case.

The patients were clinically examined at 1 to 7 (median 3) days after the onset of symptoms and at 3 months and 12 months after the stroke. Patients’ impairments were assessed by use of the Scandinavian Stroke Scale (SSS) and its performance in ADL with the Barthel Index. The degree of handicap was scored with the Rankin Scale and the severity of intellectual deterioration with the MMSE. The test battery included standardized conditions. Parallel test versions were used when 3-month and 12-month follow-up visits with the same test battery in interviews.

When appropriate, eg, in dysphasic patients, additional information time of the day, by the same psychiatrist (P.H.), who was experienced with dysthymic disorders, ignoring the 2-year criterion of DSM-III-R.

The depressive patients were older than the nondepressive ones, with the mean age of nondepressive, minor depressive, and major depressive patients being 62.4, 66.3, and 70.9 years, respectively, at 12 months after the stroke. The depressive patients were more dependent in ADL functions and had more severe impairment and handicap evaluated by the Barthel Index, SSS, and the Rankin scale than the nondepressive patients (Table 4) at both 3 and 12 months after the stroke.

**Discussion**

More than half of our ischemic stroke patients were found to have depression at the 3-month follow-up visit, and nearly half of them had depression at the 12-month visit. Although depression was mostly mild at both times, the occurrence of major depression increased during the follow-up. The major finding of the present study was that there is a significant association between the categories of depressive illness and the degree of cognitive deficits, including dysphasia, assessed by a pattern of standardized neuropsychological tests. Our
results also showed that depression was related to the degree of neurological and functional deficits and to the level of handicap of stroke patients.

In the present study we found a high prevalence of poststroke depression by using psychiatric examinations to diagnose poststroke depression. The frequency of major depression increased from 9% to 16% from 3 to 12 months after stroke. In other studies that have used psychiatric examinations to diagnose depression, the prevalence of post-stroke depression has varied from 24% to 41%, with major depression occurring in 12% to 31% of patients and minor depression in 9% to 29% of patients, depending on the time

<table>
<thead>
<tr>
<th>Table 2. Results of the Neuropsychological Tests in Nondepressive and Depressive Patients at 3 and 12 Months After Ischemic Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nondepressive</td>
</tr>
<tr>
<td>3 mo</td>
</tr>
<tr>
<td>12 mo</td>
</tr>
</tbody>
</table>

Verbal logical thinking
- Similarities† (max. 34)
  - 3 mo | 20.7 (9.7) | 15.8 (10.6) | 14.8 (9.8) | 0.051
  - 12 mo | 20.2 (8.1) | 15.7 (8.8) | 11.7 (10.7) | 0.003

Comprehension† (max. 38)
- 3 mo | 24.2 (8.3) | 18.6 (10.1) | 20.2 (12.1) | 0.023
- 12 mo | 24.7 (7.5) | 20.5 (10.0) | 17.1 (12.9) | 0.012

Nonverbal problem solving
- Picture completion† (max. 22)
  - 3 mo | 11.9 (4.6) | 9.8 (4.9) | 9.2 (2.3) | 0.062
  - 12 mo | 13.0 (4.2) | 10.7 (4.7) | 8.9 (4.9) | 0.004

- Block design† (max. 51)
  - 3 mo | 17.4 (11.9) | 10.6 (9.9) | 7.8 (6.9) | 0.005
  - 12 mo | 18.5 (12.0) | 9.6 (10.2) | 6.0 (7.8) | <0.001

Verbal memory
- Logical memory, delayed‡ (max. 23)
  - 3 mo | 7.4 (4.8) | 5.1 (4.8) | 2.1 (3.7) | 0.004
  - 12 mo | 7.7 (4.6) | 5.6 (4.8) | 3.3 (4.3) | 0.004

- Serial learning (max. 50)
  - 3 mo | 30.1 (11.8) | 25.3 (12.7) | 20.9 (15.3) | 0.045
  - 12 mo | 31.9 (10.7) | 25.8 (13.3) | 17.5 (13.5) | <0.001

Visual memory
- Visual reproduction‡ (max. 14)
  - 3 mo | 6.5 (3.6) | 4.2 (3.2) | 2.8 (2.6) | 0.001
  - 12 mo | 8.1 (3.8) | 6.6 (4.0) | 5.1 (4.5) | 0.027

- Visual recognition, delayed (max. 30)
  - 3 mo | 21.1 (6.9) | 17.8 (9.3) | 15.8 (9.7) | 0.084
  - 12 mo | 21.3 (7.4) | 20.5 (6.6) | 13.7 (9.6) | 0.004

Attention and executive functions
- Trail-Making A, s
  - 3 mo | 85.9 (57.2) | 128.4 (94.1) | 157.6 (99.6) | 0.011
  - 12 mo | 92.6 (69.8) | 130.8 (86.1) | 181.7 (106.2) | <0.001

- Verbal fluency, words/min
  - 3 mo | 8.5 (4.4) | 6.6 (5.9) | 5.4 (5.3) | 0.124
  - 12 mo | 9.7 (5.8) | 7.6 (5.1) | 4.7 (5.7) | 0.009

- Visuoconstructive functions (max. 19)
  - 3 mo | 17.1 (3.3) | 15.2 (4.4) | 14.2 (4.9) | 0.033
  - 12 mo | 17.2 (2.9) | 15.6 (4.2) | 14.4 (5.6) | 0.027

Values are given as mean (SD). Max. indicates maximum score of the scale.

*P value for difference between the 3 groups by 1-way ANOVA.
†Wechsler Adult Intelligence Scale-R subtest; ‡Wechsler Memory Scale subtest.
elapsed after stroke. Robinson et al. found a stable 14% prevalence of depression for up to 2 years. In the study of Åström et al., the majority of patients with major depression experienced remission within the first year, with the prevalence of depression decreasing from 31% at 3 months to 16% at 12 months after the stroke.

In the present study the overall prevalence of depression was even higher than in most of the previous studies, but the prevalence of major depression was lower. The differences in the prevalence of major depression may be due to the selection of the study population. Contrary to those in previous studies, our patients had experienced only their first-ever stroke, and the patients with other central nervous system lesions or previous psychiatric illnesses were excluded. The increase of the prevalence of major depression from 3 months up to 1 year may be due to the fact that patients with limited awareness of their deficits avoid depression at the acute stage. Eventually they have to face the demands of everyday life with the loss of cognitive, verbal, and functional abilities, and this may increase their depressive mood.

To our knowledge, very few previous prospective studies have been carried out using both neuropsychological tests for diagnosing cognitive impairment and psychiatric examinations for diagnosing poststroke depression. We found a clear-cut association between the categories of depressive illness and the cognitive deficits assessed by the pattern of standardized neuropsychological tests at 3 and 12 months after stroke. When comparing the simultaneous effect of depression and dysphasia on cognitive impairment, depression was an independent correlate of the tests reflecting nonverbal problem solving, memory, and attention and psychomotor speed at 12 months, but dysphasia associated with all the tests.

Stroke may cause cognitive impairment, and the domains most likely to be defective are memory, orientation, language, and attention. It is also known that depressive patients without brain damage perform poorly on cognitive tasks, especially those involving memory and concentration. In 1 study, the most vulnerable functions in major depression were memory and psychomotor speed. Our depressive stroke patients performed poorly also in the tests of nonverbal problem solving, which has not been found in the depressive patients without brain damage.

Our findings of a correlation between the global deterioration in cognitive functions and depression agree with those of previous studies that used the MMSE to diagnose cognitive impairment. The MMSE, however, has limitations, including its dependence on verbal skills to communicate the test instructions and the different degrees of sensitivity of its various items.

In the present study the prevalence of depression was high among the dysphasic patients. The presence of major depression increased during follow-up, with 12% of the dysphasic patients having major depression at 3 months after stroke and 35% at 12 months. Robinson and Benson, using self-rating scales, found depression to be common in the population of hospitalized dysphasic patients with chronic illnesses. Other studies have shown an association between dysphasia and major depression up to 3 months after the stroke but not later. Our results suggest that dysphasia, being a severely disabling condition, may markedly contribute to the severity and persistence of depression in stroke patients.

In the present study the presence of poststroke depression was associated with old age. Previously depression has been found to be frequent in young patients, while in some studies it has been related to old age. The lack of social support and both functional and cognitive impairment may increase the risk of depressive disorders in the elderly. Our depressive patients were more dependent in ADL and had more severe impairment and handicap than those without depression both at 3 and 12 months after stroke, as has been shown also in the previous studies.
In conclusion, depression is a common consequence of stroke, with more than half of the patients without previous mental disorders suffering from it. The frequency of major poststroke depression seems to increase during the first year after the stroke. In addition to neurological and functional deficits, poststroke depression is associated with dysphasia and other cognitive deficits, such as disorders of memory, nonverbal problem solving, attention, and psychomotor speed. We emphasize the importance of the psychiatric evaluation of poststroke patients, especially those with dysphasia or other cognitive deficits, not only in the acute phase but also later on.

### TABLE 3. Results of Neuropsychological Tests in Nondepressive and Depressive Patients With and Without Dysphasia at 12 Months after Stroke

<table>
<thead>
<tr>
<th></th>
<th>No Depression</th>
<th>Depression</th>
<th>P for Main Effect*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minor</td>
<td>Major</td>
<td>Dysphasia</td>
</tr>
<tr>
<td>n Dysphasia</td>
<td>8</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>n No dysphasia</td>
<td>45</td>
<td>17</td>
<td>8</td>
</tr>
<tr>
<td>Verbal logical thinking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Similarities† (max. 34)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dysphasia</td>
<td>10.3 (9.3)</td>
<td>5.7 (8.8)</td>
<td>3.0 (5.7)</td>
</tr>
<tr>
<td>No dysphasia</td>
<td>22.0 (6.5)</td>
<td>19.3 (5.6)</td>
<td>19.3 (7.8)</td>
</tr>
<tr>
<td>Comprehension‡ (max. 38)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dysphasia</td>
<td>12.8 (9.2)</td>
<td>9.0 (11.9)</td>
<td>6.1 (9.3)</td>
</tr>
<tr>
<td>No dysphasia</td>
<td>26.8 (4.8)</td>
<td>24.6 (5.1)</td>
<td>26.6 (5.8)</td>
</tr>
<tr>
<td>Nonverbal problem solving</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Picture completion† (max. 22)</td>
<td></td>
<td></td>
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<tr>
<td>Dysphasia</td>
<td>11.1 (4.3)</td>
<td>9.3 (4.4)</td>
<td>5.3 (3.1)</td>
</tr>
<tr>
<td>No dysphasia</td>
<td>13.3 (4.1)</td>
<td>11.2 (4.9)</td>
<td>12.0 (3.9)</td>
</tr>
<tr>
<td>Block design‡ (max. 51)</td>
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<tr>
<td>Dysphasia</td>
<td>8.0 (5.8)</td>
<td>8.0 (9.6)</td>
<td>2.1 (4.9)</td>
</tr>
<tr>
<td>No dysphasia</td>
<td>20.4 (11.9)</td>
<td>10.3 (10.6)</td>
<td>9.4 (8.6)</td>
</tr>
<tr>
<td>Verbal memory</td>
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<tr>
<td>Logical memory, delayed‡ (max. 23)</td>
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<td></td>
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<tr>
<td>Dysphasia</td>
<td>3.0 (3.2)</td>
<td>1.7 (2.7)</td>
<td>0.3 (0.8)</td>
</tr>
<tr>
<td>No dysphasia</td>
<td>8.6 (4.3)</td>
<td>7.0 (4.6)</td>
<td>6.0 (4.4)</td>
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<tr>
<td>Serial learning (max. 50)</td>
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<tr>
<td>Dysphasia</td>
<td>14.8 (10.1)</td>
<td>6.8 (15.2)</td>
<td>7 (10.1)</td>
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<tr>
<td>No dysphasia</td>
<td>35.0 (7.4)</td>
<td>31.4 (5.4)</td>
<td>26.8 (7.6)</td>
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<td>Visual memory</td>
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<td>Visual reproduction‡ (max. 14)</td>
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<td>Dysphasia</td>
<td>5.3 (3.7)</td>
<td>5.3 (2.9)</td>
<td>3.3 (4.1)</td>
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<td>No dysphasia</td>
<td>8.6 (3.6)</td>
<td>7.1 (4.3)</td>
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<td>14.5 (10.6)</td>
<td>19.2 (10.1)</td>
<td>8.3 (11.0)</td>
</tr>
<tr>
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<td>22.5 (6.1)</td>
<td>20.9 (5.2)</td>
<td>18.4 (5.2)</td>
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<td>Attention and executive functions</td>
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<tr>
<td>Trail-Making A, s</td>
<td></td>
<td></td>
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<tr>
<td>Dysphasia</td>
<td>156.5 (104.0)</td>
<td>182.0 (108.0)</td>
<td>249.1 (87.8)</td>
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<td>No dysphasia</td>
<td>81.3 (56.3)</td>
<td>111.6 (71.1)</td>
<td>122.8 (86.3)</td>
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<tr>
<td>Verbal fluency, words/min</td>
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<tr>
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<td>1.5 (2.0)</td>
<td>2.1 (5.2)</td>
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<td>No dysphasia</td>
<td>11.0 (5.3)</td>
<td>9.8 (4.0)</td>
<td>7.0 (5.4)</td>
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<tr>
<td>Visuoconstructive functions (max. 19)</td>
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<td>14.4 (5.1)</td>
<td>12.7 (5.9)</td>
<td>10.7 (6.9)</td>
</tr>
<tr>
<td>No dysphasia</td>
<td>17.7 (2.0)</td>
<td>16.6 (3.0)</td>
<td>17.1 (1.7)</td>
</tr>
</tbody>
</table>

Values are given as mean (SD). Max. indicates maximum score of the scale.

*Statistical significance evaluated by 2-way ANOVA.
†Wechsler Adult Intelligence Scale-R subtest; ‡Wechsler Memory Scale-R subtest.
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References

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