Summarizing our findings we noted that after the follow-up period (median 53 months) half of the patients were fully independent in ADL. One-fifth of all patients could return to work, one-fifth required assistance, one-fifth had died, and one-tenth was disabled.

The patients' condition at the acute stage was of prime importance in the early prognosis and the functional recovery in our series as in previous studies. In our series the survival was independent of the patients' age, which agreed with previous reports. On the other hand, functional recovery was much better in the younger age groups. The same was found in most previous series dealing with this question.

It is well known that cigarette smoking is a risk factor of cerebrovascular disease. In the present series it could also be shown that prognosis and functional recovery were better in nonsmokers than in smokers. Hypertension, again, was of no prognostic value.

It is also well known that patients with cerebrovascular disease often die due to coronary heart disease. This was also noted in our series where equal numbers of deaths were due to cerebrovascular and coronary heart diseases. This supports the concept of universal atherosclerosis as a basic etiology in ICA occlusion.

References


Prognosis of Patients With Middle Cerebral Artery Occlusion

MARKKU KASTE, M.D., AND OLLI WALTIMO, M.D.

SUMMARY The long-term prognosis of 78 stroke patients with occlusion of the middle cerebral artery (MCA) or its branches is described. The mean age of the patients was 44 years. The mortality rate in the acute phase was 5%. The acute and total mortality rates of men were higher than those of women (p < 0.05). Life-table analysis gave 94% probability for one year's survival, 84% for three years' survival, and 78% for five years' survival. Subsequent strokes were twice as common as cardiovascular events as the cause of death. Seventy-two percent of the survivors became fully independent in activities of daily living (ADL), 27% required assistance, 1% was totally disabled, and 43% returned to work. Left-sided occlusion was overrepresented in those who died (p < 0.001) and those who returned to work (p < 0.05), and right-sided occlusion was overrepresented in those who required assistance in ADL (p < 0.05).

Introduction

NUMEROUS STUDIES have dealt with long-term prognosis of stroke and various types of stroke, while little attention has been paid to the clinical entity of occlusion of one major cerebral artery. It would be desirable in clinical routine work to know the stroke patient's long-term prognosis evaluated on this basis, since this type of stroke is frequently encountered. Therefore, we have analyzed the long-term prognosis of stroke patients with occlusion of the middle cerebral artery (MCA) or its branches.

Patients and Methods

From the 1966 to 1973 files of the Department of Neurology, University of Helsinki (Finland), 83 patients with ischemic brain infarction and occlusion of the MCA or its branches, verified angiographically or by autopsy, were found. Etiological causes other than ischemic were excluded.

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by all relevant methods which included neuroradiology, EEG studies, brain scans, CSF examination, etc. Transient ischemic attacks (TIA) were excluded by accepting only those patients with symptoms and signs which had lasted longer than 24 hours.

The majority of patients had symptoms and signs of unilateral motor and/or sensory disturbances associated with ipsilateral facial paresis, visual field defects, and dysphasia or aphasia if the dominant hemisphere was involved.

In December, 1973, a questionnaire was mailed to the patients. They were asked about their working capacity and independence in the activities of daily living (ADL) before and after the stroke. Death certificates and autopsy records, if any, also were studied. Five patients could not be traced and had to be omitted from the analysis. For statistical analysis of the data, the Chi-square method and Student's t-test were used.

The age and sex distributions of the patients in this study are shown in table 1. The mean follow-up time was 30.3 months (range: 0 to 102 months).

### Results

During the follow-up period, 11 patients had died (two women and nine men). The causes of death are shown in table 2. It is seen that subsequent strokes were a cause of death twice as often as cardiovascular disease.

Only four male patients (5%) died in the acute stage of stroke. The case-fatality rate for men was higher than for women during the acute stage (p < 0.05), and the total mortality rate for men was higher than for women during the follow-up period (p < 0.05).

The mean age of those who died was 60 years, which does not differ significantly from the mean of the entire series (44 years).

A life-table analysis of the data gives a 94% probability of surviving the first year, 84% the third year, and 78% the fifth year after stroke.

Occlusion of the MCA occurred on the left side in 53 patients and on the right side in 25 patients, the difference being highly significant (p < 0.001). Of the 53 patients, 21 had MCA occlusion and 32 had occlusion of the MCA branches on the left side, while of 25 patients, two had MCA occlusion and 23 had occlusion of the MCA branches on the right side; the difference was highly significant (p < 0.005).

Localization of occlusion according to sex is shown in table 3. Men had occlusion in 18 instances and women in five, the difference being statistically significant (p < 0.01). The age at onset of symptoms presented no difference between MCA occlusion (mean age: 45 years) or its branches (mean age: 43 years). At onset of symptoms, the mean age of women was 40 years, which does not differ significantly from the mean age of men (46 years).

The patients were divided into three categories according to how they managed in ADL: Group 1 — fully independent in ADL, Group 2 — persons requiring assistance in ADL, and Group 3 — totally disabled.

Of those patients who survived the acute stage of stroke, 53 (72%) became fully independent in ADL, 20 (27%) required assistance, and one (1%) was totally dependent (table 4). There were no differences in sex distribution between these groups. The mean age of the patients was 40 years in Group 1 and 48 years in Group 2; the patient who remained totally disabled was 66 years old. Thirty-two patients (43%) were able to return to work (mean age 38 years). There were no significant differences between the ages of these groups. Thirty (57%) of the 53 fully independent patients were able to return to work, while only two (10%) of the 20 patients who required assistance in ADL were able to return to work.

At the onset of symptoms there were 16 patients with total hemiparesis and 43 with hemiparesis. Consciousness was reduced in eight patients. Seven patients (13%) who were fully independent had total hemiparesis in the acute stage, compared to eight (40%) of those requiring assistance in ADL; the difference is highly significant (p < 0.0005). Only three of those patients able to return to work had total hemiparesis at the onset of symptoms (table 5). Only one of the patients who died in the acute stage of stroke had reduced consciousness. None of these patients had total hemiparesis.

All patients who died in the acute stage of stroke or during the follow-up period had occlusions on the left side. These left-sided occlusions were overrepresented at an almost significant level (p < 0.05) among the patients who died in the acute stage, and at a highly significant level (p < 0.001) among those patients who died during the follow-up period.

Localization of MCA occlusions in relation to the patient’s ability to return to work is shown in table 6. Left-sided occlusion of the MCA was more common among those patients who returned to work than those who did not

### Table 1: Age and Sex Distributions

<table>
<thead>
<tr>
<th>Age</th>
<th>Men</th>
<th>Women</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20</td>
<td>3</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>20-29</td>
<td>2</td>
<td>7</td>
<td>9</td>
</tr>
<tr>
<td>30-39</td>
<td>8</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>40-49</td>
<td>12</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>50-59</td>
<td>6</td>
<td>3</td>
<td>9</td>
</tr>
<tr>
<td>60-69</td>
<td>4</td>
<td>3</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td>46</td>
<td>32</td>
<td>78</td>
</tr>
</tbody>
</table>

### Table 2: Causes of Death

| Initial stroke | 4 |
| Subsequent stroke | 4 |
| Coronary heart disease | 1 |
| Other cardiovascular disease | 1 |
| Cancer | 1 |
| Total | 11 |

### Table 3: Location of MCA Occlusion

<table>
<thead>
<tr>
<th>Branch</th>
<th>Left Occlusion</th>
<th>Right Occlusion</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Men</td>
<td>Women</td>
</tr>
<tr>
<td>Branch</td>
<td>14</td>
<td>18</td>
</tr>
<tr>
<td>occlusion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occlusion</td>
<td>31</td>
<td>22</td>
</tr>
<tr>
<td>Total</td>
<td>44</td>
<td>37</td>
</tr>
</tbody>
</table>

### Table 4: Functional Recovery of Survivors

<table>
<thead>
<tr>
<th>ADL</th>
<th>Fully independent</th>
<th>Requiring assistance</th>
<th>Totally dependent</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Men</td>
<td>28 (67)*</td>
<td>14 (33)</td>
<td>1 (3)</td>
<td>42</td>
</tr>
<tr>
<td>Women</td>
<td>25 (78)</td>
<td>6 (19)</td>
<td>1 (3)</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>53 (72)</td>
<td>20 (27)</td>
<td>1 (3)</td>
<td>74</td>
</tr>
</tbody>
</table>

*Numbers in parentheses are percent.
(p < 0.05). There was no statistically significant difference in the distribution of occlusion of the MCA or its branches between those who were able to return to work and those who were not.

Localization of MCA occlusions in relation to ADL is shown in table 7. Occlusions of the right MCA were more common among those who required assistance in ADL than among those who were fully independent (p < 0.05). Left MCA occlusions were more common among those fully independent than among those requiring assistance in ADL (p < 0.05).

Discussion

Although this type of stroke is not uncommon, very little attention has been paid to the functional recovery and long-term prognosis of occlusion of the MCA or its branches.1

The patients of the present series had either occlusion of the MCA or its branches which was verified by angiography or autopsy. In considering the results we obtained, one should reflect on our method of selecting patients: all patients with ischemic brain infarction admitted to our hospital are not treated in the Department of Neurology; quite often, and especially when they are elderly, they are treated by the Departments of Medicine. There is also the selection of those patients referred from other hospitals: elderly and seriously ill patients are preferentially treated in the hospital of primary admission. Furthermore, all stroke patients in the Department of Neurology are not examined by angiography; an elderly patient showing signs of universal arteriosclerosis often escapes angiographical examination because of the risk of complications. This is why the mean age is only 44 years in the present series; however, it is almost identical with previous series.1,2

The mortality rate (5%) in the acute stage is low compared with earlier hospital series reporting case fatalities of non-embolic and/or embolic brain infarction in the acute phase between 10% and 35%.3,4 This most likely was due to the fact that in this series the patients were quite young and all had occlusion of the MCA which supplies only part of one hemisphere; there was no severe brain edema, which in severe stroke is the main reason for patient deaths.5

All those patients who died in the acute phase of stroke were men; their mean age was slightly higher than that of the entire series. In general, according to the literature, the risk of early fatality from stroke increases with age. Almost as universally, the prognosis has been shown to be independent of sex. However, some authors have found a slightly higher case fatality of men in most age groups.6,7 In other series, the poor prognosis of women has been explained by their increased mean age.8,9 In the present series, the mean age of the men was slightly higher than that of the women. The probability of survival in the present series (78% after five years) seems to be better than that in earlier studies with their five-year survival rates between 38% and 66%.1,2,6,8,10,14,17

This difference may be explained by the selective factors mentioned in which the most severely ill and elderly patients were underrepresented.

The causes of death in the present series are similar to those in most earlier studies: subsequent strokes were twice as common as cardiovascular disease.12,13

Functional recovery was excellent in our series: 72% of the patients who survived the acute phase of stroke became fully independent in ADL, while 27% required assistance in ADL, and only one (1%) was totally disabled. In earlier studies the percentages of independent patients varied between 40% and 63%.1,2,5,8,9,10,15,18-21. In some studies the percentage of survivors with a good recovery has been particularly low, i.e., 12% to 17%.19-24 It is difficult to draw any solid conclusion from the heterogeneous literature. However, the reason for better functional recovery in this series is believed to be that the patients were relatively young and had occlusion of only the MCA or its branches. The significance of age also is evident in the mean ages of the different ADL groups: the patients who became fully independent were younger on the average than those who required assistance in ADL.

In the present series 43% of the survivors regained their working capacity, which agrees with earlier studies reporting figures from 30% to 40%,9,10,12,18,25 The mean age of the patients who were able to return to work was 38 years. Younger patients are more likely to regain their working capacity since they are better able to compensate for the lost function of the infarcted regions of the brain.

Left-sided occlusion of the MCA was more common among those who were able to return to work (p < 0.05), and right-sided occlusion among those who required assistance in ADL (p < 0.05). Marquardsen12 suggested the

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**Table 5 Clinical Status at the Onset of Symptoms**

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Fully independent (n = 33)</th>
<th>Requiring assistance (n = 20)</th>
<th>ADL Totally dependent (n = 1)</th>
<th>Died in acute phase (n = 4)</th>
<th>Returned to work (n = 32)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hemiparesis</td>
<td>7</td>
<td>8</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Hemiplegia</td>
<td>31</td>
<td>9</td>
<td>1</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Reduced consciousness</td>
<td>5</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

**Table 6 Location of MCA Occlusion in Those Patients Who Returned to Work and Those Who Did Not**

<table>
<thead>
<tr>
<th>Branch occlusion</th>
<th>Left</th>
<th>Right</th>
</tr>
</thead>
<tbody>
<tr>
<td>Returned to work</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>Did not return to work</td>
<td>14</td>
<td>11</td>
</tr>
</tbody>
</table>

**Table 7 Location of MCA Occlusion in Each ADL Group**

<table>
<thead>
<tr>
<th>ADL</th>
<th>Left occlusion</th>
<th>Right occlusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully independent</td>
<td>23</td>
<td>15</td>
</tr>
<tr>
<td>Requiring assistance</td>
<td>7</td>
<td>3</td>
</tr>
<tr>
<td>Totally dependent</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

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CEREBRAL INFARCTION IN THE MONGOLIAN GERBIL/McGraw et al. 485

reason for this was that the lesions of the right hemisphere affect the functions of visuomotor, temporal and spatial concepts.

References


Cerebral Infarction in the Mongolian Gerbil Exacerbated by Phenoxybenzamine Treatment

C. Patrick McGraw, Ph.D.,† Annette G. Pashayan, A.B.,* and O. T. Wendel, Ph.D.*

SUMMARY In a double-blind study, the effects of a large dose (20 mg per kilogram) and a small dose (2 mg per kilogram) of phenoxybenzamine (PBZ) on cerebral infarction were evaluated in 120 Mongolian gerbils. The left common carotid artery was ligated in 100 animals; a sham operation was done in 20 animals. One hour later, 25 animals were given 2 mg per kilogram of PBZ, 25 animals were given 20 mg per kilogram of phenoxybenzamine, and 50 animals were given 0.5 cc of normal saline, all doses being repeated at 24, 48, and 72 hours. Five sham-operated animals were given 2 mg per kilogram of phenoxybenzamine, five were given 20 mg per kilogram of phenoxybenzamine and ten were given 0.5 cc of normal saline on the same treatment schedule. Morbidity and mortality were recorded for one week and then all surviving animals were killed. All brains were studied for signs of infarction. Of the saline-treated animals, 32% had cerebral infarction and 81% of these died. Of the animals treated with phenoxybenzamine, 36% of those receiving 2 mg per kilogram and 68% (p < 0.05) of those receiving 20 mg per kilogram had cerebral infarction and all of those with infarction died during the observation period. The animals receiving phenoxybenzamine had a larger stroke index than those treated with saline. The authors concluded that phenoxybenzamine is harmful in post-ischemic treatment of strokes.

WHEN ISCHEMIA develops after brain or spinal cord trauma or hemorrhage, monoamine neurotransmitters may leak from neurons that have lost their structural integrity as a result of that ischemia.1-3 These neurotransmitters have been postulated to alter nerve cell metabolism, depress neuronal function, produce cerebral edema,4-6 cause cerebral arterial vasospasm7,8,9,10 and increase platelet aggregation.11,12 Mechanisms that normally inactivate these neurotransmitters, namely presynaptic re-uptake and oxidative deamination, are attenuated due to the lack of oxygen, and the accumulation of these substances in the extracellular space exacerbates the damage caused by the initial ischemia.1,2,7

This information suggests several approaches to the pharmacological therapy of stroke: (1) inhibition of neurotransmitter synthesis, (2) suppression of the release of neuro-

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Reprint requests to Dr. McGraw.
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M Kaste and O Waltimo

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