Positive Scans in Angiographically Proved Cases of Recanalized Cerebral Infarction

BY TADAYOSHI IRINO, M.D., MAMORU TANEDA, M.D., AND TAKAO MINAMI, M.D.

Abstract:
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In 20 patients with acute major cerebral arterial occlusion, follow-up angiograms were obtained to inspect the occluded artery. These angiograms were compared with brain scans in the fourth week after the stroke. The angiograms revealed that frequent recanalization of the occluded arteries occurred within a week after the onset. On the other hand, brain scans showed the increased uptake of radioisotopes even in the patients with angiographically demonstrated arterial recanalization.

The present study clarified that positive scans could be obtained in the patients with and without recanalization, and emphasized the diagnostic value of brain scans in the subacute or chronic stage of cerebral infarction, especially in patients with no arterial occlusion appearing on the angiograms.

Additional Key Words
- cerebral thrombosis
- cerebral circulation
- radioisotope scanning
- cerebral embolism
- stroke

During a study of patients who had cerebral infarction, brain scans frequently showed increased uptake of radioisotopes in the territory of the middle cerebral artery, even in those cases without angiographically documented arterial occlusion. Although absence of arterial occlusion on angiography was often suspected to be a result of recanalization, as yet there has been no sufficient clinical report concerning brain scans in recanalized cerebral infarction confirmed by follow-up angiography.

The present study was designed to compare brain scans with follow-up angiography in 20 stroke patients with internal carotid or middle cerebral arterial occlusion.

Methods
This series comprised 20 patients who had acute major cerebral arterial occlusion among 228 stroke patients who were admitted to the Division of Cerebrovascular Disease of Hanwa Hospital between May 1973 and July 1974. All 228 patients were diagnosed on the basis of physical and angiographical findings within 24 hours of the stroke. These 20 patients complained of sudden onset of hemiplegia with some confusion and were admitted for more than one month. Eight of them had internal carotid arterial occlusion and the other 12 had occlusion at the proximal portion of the middle cerebral artery. Fourteen of them were cases of thrombosis due to arteriosclerosis and the remaining six cases were diagnosed as having cerebral embolism associated with atrial fibrillation. Fibrinolytic agents were not used for these patients.

The first angiogram was performed within 24 hours after onset, using 7 ml of 60% Amidotrizoate. The second was done on the third day to follow up the occluded artery. When recanalization was not demonstrated, an angiogram was repeated on the seventh day. Final angiography was performed on the next day when the brain scan also was performed. The term "recanalization" was used as perfect and full arterial restoration, and even a minimal arterial obstruction was excluded from the present study.

Brain scanning was done in the fourth week after the stroke. It was started 15 minutes after intravenous injection of 10 mc of 99m Tc-pertechnetate. The scanning results were divided into three categories: negative, equivocal and positive. The scan was interpreted as negative when the uptake of isotopes was defined to the osseous and muscular tissues of the head or the dural or air sinuses. The scan was considered equivocal if the area of radioactivity within the brain substance appeared to be small and of questionable significance. The diagnosis of a positive scan was based on the appearance of a well-defined area of radioactivity within the brain substance.

To facilitate our analysis of this study, neurological deficits were divided into two groups according to the severity of the hemiparesis: severe and moderate. Severe was used for those patients who required assistance in walking or could not walk at all after one month following the stroke, and moderate for those who were able to walk without any assistance.

The design of procedure of angiography and brain scanning is shown in figure 1.

Results
In four patients (Cases 1, 4, 6 and 7) with internal carotid arterial occlusion and five patients (Cases 9, 11, 12, 18 and 19) with middle cerebral arterial occlusion, the follow-up angiography showed complete...
clearing of the whole carotid arterial tree within seven days after the stroke. In the remaining 11 cases no recanalization was demonstrated.

The clinical course of all recanalized cases was judged as severe, while four of the non-recanalized cases were judged as moderate, and the remaining seven as severe.

Fifteen had positive brain scans, one had an equivocal scan and four had negative scans. Nine cases (Cases 1, 4, 6, 7, 9, 11, 12, 18 and 19) with recanalization showed positive scans in the territory of the middle cerebral artery. All the patients showing positive scans had severe neurological deficits, while those without abnormal uptake of radioisotopes had moderate deficits.

Summarizing the results described above, those patients with severe neurological deficits showed abnormal scans without any relation to the angiographically demonstrated circulatory restoration after recanalization.

Discussion

It is widely accepted that spontaneous recanalization of the occluded arteries frequently occurs in cerebral infarction. It should be kept in mind, therefore, that cerebral angiography performed after recanalization has no diagnostic value. In our present study of 20 cases, although information was not provided by cerebral angiography in recanalized cerebral infarction, a positive brain scan performed a few weeks after the stroke accurately indicated the localization of the infarcted area.

There are few facts, if any, regarding the
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TABLE 1
Results of Follow-Up Angiography, Brain Scans, and Neurological Deficit

<table>
<thead>
<tr>
<th>Case no.</th>
<th>Age, sex</th>
<th>Recanalized</th>
<th>Brain scan</th>
<th>Neurological deficit</th>
</tr>
</thead>
<tbody>
<tr>
<td>ICA occlusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1*</td>
<td>47 F</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>2</td>
<td>49 F</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>3*</td>
<td>57 M</td>
<td>+</td>
<td>Equivocal</td>
<td>Severe</td>
</tr>
<tr>
<td>4*</td>
<td>71 M</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>5</td>
<td>60 M</td>
<td>+</td>
<td>Negative</td>
<td>Moderate</td>
</tr>
<tr>
<td>6</td>
<td>66 M</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>7*</td>
<td>74 F</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>8</td>
<td>64 F</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>MCA occlusion</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>59 F</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>10</td>
<td>69 M</td>
<td>+</td>
<td>Negative</td>
<td>Moderate</td>
</tr>
<tr>
<td>11*</td>
<td>71 F</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>12</td>
<td>66 M</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>13</td>
<td>64 M</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>14</td>
<td>69 F</td>
<td>+</td>
<td>Negative</td>
<td>Moderate</td>
</tr>
<tr>
<td>15</td>
<td>58 M</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>16</td>
<td>70 M</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>17</td>
<td>74 M</td>
<td>+</td>
<td>Negative</td>
<td>Moderate</td>
</tr>
<tr>
<td>18*</td>
<td>73 M</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>19</td>
<td>79 F</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
<tr>
<td>20</td>
<td>58 M</td>
<td>+</td>
<td>Positive</td>
<td>Severe</td>
</tr>
</tbody>
</table>

*Patient with atrial fibrillation. + = recanalized case.
ICA: internal carotid artery, MCA: middle cerebral artery.

The mechanism of a positive scan within the infarcted tissues has been suggested that abnormal uptake of radioisotopes is related to various pathological processes such as breakdown of the blood-brain barrier, necrosis, edema or glial reaction. It is generally presumed that those pathological processes are the result of ischemia following arterial occlusion in cerebral infarction. The zone of increased radioactivity has been reported as corresponding well to the site of the infarction determined with clinical examination or at autopsy. Many authors reported that the patients with the most severe clinical manifestations and neurological deficits usually showed a large area of abnormal radioactivity on the brain scans and those with less severe signs or symptoms often showed a smaller area of tracer localization.

In our present cases as well as previous reports, angiographically demonstrated circulatory restoration following recanalization did not contribute to the recovery of neurological deficits. Thus there is no doubt that an abnormal uptake of radioisotopes, which reflects those ischemic lesions caused by arterial block, was obtained even after the occurrence of recanalization. In this series, the positive scans and the severe neurological deficits were apt to appear more frequently in recanalized cases than in non-recanalized ones; however, this demands further investigation to be confirmed.

It is clear from the data mentioned above that positive scans were obtained in those patients with severe clinical manifestations, even if the infarcted areas were not shown on the angiograms following recanalization. Therefore, in the subacute or chronic stage of cerebral infarction, as schematically indicated in figure 5, brain scans had more diagnostic value than...
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cerebral angiograms, because the latter frequently showed no arterial occlusion at this stage.

References
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