Transient Ischemic Attacks and Strokes with Recovery Prognosis and Investigation


SUMMARY This study analyzes 234 patients who recovered from an initial ischemic episode. The object was to see if the duration of the first episode influenced the chance of finding a treatable lesion or the chance of a further episode. The initial episodes varied from less than 5 minutes to longer than 3 weeks. There seemed to be no fundamental difference between transient ischemic attacks (TIAs) (less than 24 hours) and strokes which recover. However, 51% of those whose initial episode lasted less than 5 minutes had a subsequent stroke compared to 28% of those with an initial episode of more than 24 hours duration. Thirty percent of the former group who had angiograms had an operable lesion against 10% in the latter group. It seems that angiography has sufficiently high yield to be warranted in all patients where the initial attack lasted less than 30 minutes. In those with longer attacks the yield from angiography was much lower and noninvasive techniques should be considered in these patients, where available, prior to consideration for angiography.

Investigation should be based on the degree of functional recovery and not on the arbitrary time division which normally divides TIAs and strokes.

Bruits were the most reliable clinical indicators of stenosis. However the presence of intermittent claudication, hypertension and age over 50 were all more common in those with carotid stenosis.

There have been many studies concerned with the natural history, investigation, and management of transient ischemic attacks (TIAs). These were comprehensively reviewed by Brust in 1977. Transient ischemic attacks are defined as focal neurological deficits of vascular origin, rapid in onset, with complete recovery in less than 24 hours. While the majority of authors have accepted the definition of a TIA as lasting up to 24 hours, some have taken a shorter duration. Acheson and Hutchinson, for example, considered TIAs to be any event lasting up to 1 hour while others have taken periods as short as 30 minutes. Not all patients whose signs or symptoms last longer than 24 hours are left with a permanent deficit. The Stroke Program at the National Institutes of Health, Bethesda, Maryland, recommends that those who recover within 21 days be considered to have had reversible ischemic neurological deficits (RIND). The clinical features of TIAs are, by definition, completely reversible and because of this have not usually been considered to be associated with any structural damage. However, there is evidence that this may not always be the case. For instance, while the CT scan is usually normal, it is known that infarcts are sometimes seen after what was believed clinically to be a TIA. Cerebral blood flow studies in TIA may remain focally abnormal for as long as 90 days after the last clinical event.

The present study sought to determine the significance of the duration of the first ischemic disturbance with regard to its cause and the prognosis for further episodes. The question asked was: Is there any...
fundamental difference between a person with a TIA who subsequently has an incapacitating stroke or someone whose initial episode was an RIND or stroke followed by complete recovery who later experienced a second, and this time, incapacitating stroke? This is a question which repeatedly faces the clinician who must decide about the appropriate management of the initial episode of whatever kind.

Patients and Methods

The series consisted of 234 patients referred to one of us (JM) in whom the initial episode, whether TIA, RIND or completed stroke, had been followed by complete or almost complete recovery. All were diagnosed on clinical grounds, combined with the results of investigations, as having experienced a non-hemorrhagic cerebrovascular lesion. All could, with reasonable confidence, be ascribed to the carotid or vertebrobasilar (VB) territory. Patients in whom there was doubt about either the site of the lesion or its pathology were excluded. The period of study covers 1975–1980.

There were 117 TIAs, that is, recovering in less than 24 hours. Patients recovering between 1 day and 3 weeks, thus representing reversible ischemic neurological deficits (RIND), numbered 42. Finally, 75 patients either recovered in a period longer than 3 weeks or were left with mild neurological deficit insufficient to interfere with either normal living or working activities.

These 234 patients were then classified according to the length of their first ischemic episode. Many, of course, had had more than one episode by the time of admission to hospital, but it was always the first episode which was taken as reference. This study is, therefore, both retrospective and prospective.

Patients were divided into those in whom the first episode lasted less than 5 minutes, between 5 and 30 minutes, from 30 minutes to 24 hours, between 1 day and 21 days and longer than 3 weeks.

The attacks were classified in terms of a particular vascular territory involved. Monocular blindness, dysphasia, hemisensory loss and hemiparesis were considered carotid, while bilateral loss of vision, ataxia, diplopia and drop attacks were interpreted as vertebrobasilar (VB). The blood pressure used was the stable reading obtained at the time they were first seen.

The patients were part of an ongoing study of cerebrovascular disease, details of the initial episode and subsequent follow up being recorded on specially designed punch cards from which the data was extracted.

Results

The basic data are shown in table 1.

Attacks Lasting Less Than 5 Minutes

There were 39 patients in this group of whom 26 had carotid and 13 VB TIAs. Twenty subsequently had a further episode lasting more than 24 hours (table 2). Of these, 17 were carotid and in 15 the stroke was in the same territory as the TIA. Fourteen of the 20 patients suffered the CVA less than 6 months after the first attack; in 3 the interval was between 6 and 12 months, and in 3 it was longer than 1 year. The mean number of TIAs prior to stroke was 5, although the scatter was wide. Fourteen had bruits of which 12 were carotid. Nine of the 12 had angiograms, 7 of which showed a carotid stenosis.

CT scans were performed in 18 (46%). Nine of these were normal, 3 showed an infarct and 6 had atrophy. The 3 showing an infarct had already experienced their subsequent stroke before the CT scan was performed. None of the patients showing infarction was scanned after the TIA but before the stroke.

Angiography was carried out in 23 (59%). Nine of the 23 had a stenosis of the internal carotid artery. Seven of these had a bruit. Four showed occlusion of the internal carotid artery and one had multiple peripheral occlusions. All of these patients had already suffered a second episode lasting more than 24 hours, i.e., a stroke.

Eighteen patients had other vascular disease: 8 involved the myocardium, 8 had claudication and 2 had cardiac arrhythmias.

Seven patients had an endarterectomy; this represents 30% of those who had angiograms. Five had a bruit. Four of these 7 patients had experienced a stroke subsequent to their carotid TIA before endarterectomy was done. Three had CT scans, 1 of which showed an infarct.

Attacks Lasting 5 to 30 Minutes

The initial episode lasted between 5 and 30 minutes in 44 patients. Twenty-seven were carotid and 17 VB. Thirteen subsequently had a stroke. Of these, 10 were carotid and in 9 the stroke was in the same territory as the TIA. Ten patients suffered the stroke less than 6 months after the initial TIA; in 1 the interval was between 6 and 12 months and in 2 it was greater than 1 year. The mean number of TIAs prior to cerebrovascular attack (CVA) was 4, the number varying from a single attack to several attacks per day.

Nine had bruits of which 7 were carotid. Seven had angiograms, 4 showing carotid stenosis.

CT scans were performed in 22 (50%). Five of these showed an infarct; all but one patient in this group had already had a subsequent stroke after the initial TIA before the scan was performed. However in 1 patient, an infarct was present on the CT scan although the patient clinically had only a TIA.

Angiography was performed in 25 (57%). A stenosis was found in 8 patients, 4 of whom had bruits. Occlusion was present in 5; 2 of these 5 had suffered a second episode lasting more than 24 hours. One out of 5 occlusions involved small peripheral vessels, while in 4 the internal carotid was occluded.

Six patients had endarterectomy (24% of those who
TABLE 1  Clinical History and Findings on Investigation in 234 Patients with TIA and Stroke with Recovery

<table>
<thead>
<tr>
<th>Length of time of initial episode</th>
<th>Less than 5 mins</th>
<th>5-30 mins</th>
<th>30 mins-24 hrs</th>
<th>1-21 days</th>
<th>3 weeks +</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number</td>
<td>39</td>
<td>44</td>
<td>34</td>
<td>42</td>
<td>75</td>
</tr>
<tr>
<td>Age (mean)</td>
<td>56 ± 8.5</td>
<td>59 ± 8.9</td>
<td>58 ± 9.6</td>
<td>55 ± 12</td>
<td>55 ± 12.7</td>
</tr>
<tr>
<td>Territory</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Carotid</td>
<td>26</td>
<td>27</td>
<td>21</td>
<td>36</td>
<td>57</td>
</tr>
<tr>
<td>VB</td>
<td>13</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>Bruits (cervical)</td>
<td>14</td>
<td>9</td>
<td>6</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>CT scan</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>18</td>
<td>22</td>
<td>14</td>
<td>21</td>
<td>42</td>
</tr>
<tr>
<td>Normal</td>
<td>9 (50%)</td>
<td>12 (55%)</td>
<td>10 (71%)</td>
<td>8 (38%)</td>
<td>17 (38%)</td>
</tr>
<tr>
<td>Infarct</td>
<td>3 (17%)</td>
<td>5 (22%)</td>
<td>2 (14%)</td>
<td>11 (52%)</td>
<td>20 (48%)</td>
</tr>
<tr>
<td>Atrophy</td>
<td>6 (33%)</td>
<td>5 (23%)</td>
<td>2 (14%)</td>
<td>2 (10%)</td>
<td>5 (14%)</td>
</tr>
<tr>
<td>Angiography</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>23</td>
<td>25</td>
<td>20</td>
<td>23</td>
<td>34</td>
</tr>
<tr>
<td>Normal</td>
<td>2 (8%)</td>
<td>5 (20%)</td>
<td>5 (25%)</td>
<td>10 (42%)</td>
<td>7 (21%)</td>
</tr>
<tr>
<td>Stenosis (carotid)</td>
<td>9 (39%)</td>
<td>8 (32%)</td>
<td>3 (15%)</td>
<td>3 (13%)</td>
<td>7 (21%)</td>
</tr>
<tr>
<td>Occlusion</td>
<td>5 (22%)</td>
<td>5 (20%)</td>
<td>3 (15%)</td>
<td>4 (17%)</td>
<td>6 (18%)</td>
</tr>
<tr>
<td>Atheroma</td>
<td>7 (31%)</td>
<td>7 (28%)</td>
<td>9 (40%)</td>
<td>6 (26%)</td>
<td>14 (41%)</td>
</tr>
<tr>
<td>Endarterectomy (% of those who had angiograms)</td>
<td>7 (30%)</td>
<td>6 (24%)</td>
<td>1 (5%)</td>
<td>2 (9%)</td>
<td>5 (15%)</td>
</tr>
<tr>
<td>Mean follow up (after initial event) months</td>
<td>25</td>
<td>19</td>
<td>32</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>Range (1 m to 12 yr)</td>
<td>(2 m to 14 yr)</td>
<td>(1 m to 10 yr)</td>
<td>(2 m to 5 yr)</td>
<td>(3 m to 11 yr)</td>
<td></td>
</tr>
<tr>
<td>Blood pressure (mean for the group)</td>
<td>152/90</td>
<td>150/107</td>
<td>154/90</td>
<td>149/89</td>
<td>153/91</td>
</tr>
<tr>
<td>No. hypertensive BP &gt; 140/90</td>
<td>23 (59%)</td>
<td>26 (59%)</td>
<td>19 (58%)</td>
<td>23 (59%)</td>
<td>46 (61%)</td>
</tr>
<tr>
<td>Cardiovascular disease</td>
<td>18</td>
<td>20</td>
<td>7</td>
<td>14</td>
<td>22</td>
</tr>
<tr>
<td>Myocardial</td>
<td>8</td>
<td>10</td>
<td>4</td>
<td>12</td>
<td>14</td>
</tr>
<tr>
<td>Arrhythmias</td>
<td>2</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Claudication (peripheral)</td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>Valvular heart disease</td>
<td>—</td>
<td>1</td>
<td>—</td>
<td>—</td>
<td>3</td>
</tr>
</tbody>
</table>

had angiograms). Four of these had bruits. Three subsequently had a stroke after the TIA, but before the endarterectomy. All 3 had CT scans of which 2 showed evidence of an infarct.

Attacks Lasting 30 Minutes to 24 Hours

There were 34 patients in this group; 21 suffered carotid and 13 VB attacks. Eleven subsequently had an episode lasting longer than 24 hours. Ten were carotid and in 10 the CVA was in the same territory as the TIA. Bruits were present in 6, of which 4 were carotid. Three had angiograms of which 2 had a carotid stenosis.

CT scans were performed in 14 (41%). Infarcts were seen in 2 patients, both of these having already suffered a further episode lasting more than 24 hours (i.e., stroke) before the CT scan was performed.

Twenty patients (59%) had angiograms. Three patients had a stenosis, 2 with carotid bruits. One

TABLE 2  Prognosis After Initial Episode

<table>
<thead>
<tr>
<th>Length of time of initial episode</th>
<th>Less than 5 mins</th>
<th>5-30 mins</th>
<th>30 mins-24 hrs</th>
<th>1-21 days</th>
<th>3 weeks +</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>TIA one only</td>
<td>1 (3%)</td>
<td>9 (20%)</td>
<td>5 (15%)</td>
<td>—</td>
<td>—</td>
<td>15 (13%)</td>
</tr>
<tr>
<td>TIA more than one</td>
<td>18 (46%)</td>
<td>22 (50%)</td>
<td>18 (53%)</td>
<td>—</td>
<td>—</td>
<td>58 (50%)</td>
</tr>
<tr>
<td>TIA progressing to stroke</td>
<td>20 (51%)</td>
<td>13 (30%)</td>
<td>11 (32%)</td>
<td>—</td>
<td>—</td>
<td>44 (38%)</td>
</tr>
<tr>
<td>Stroke — one only</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>15 (36%)</td>
<td>53 (71%)</td>
<td>68 (56%)</td>
</tr>
<tr>
<td>Stroke followed by TIA</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>11 (26%)</td>
<td>5 (7%)</td>
<td>16 (14%)</td>
</tr>
<tr>
<td>Stroke progressing to 2nd stroke</td>
<td>—</td>
<td>—</td>
<td>—</td>
<td>16 (38%)</td>
<td>17 (23%)</td>
<td>33 (28%)</td>
</tr>
<tr>
<td>Total</td>
<td>39</td>
<td>44</td>
<td>34</td>
<td>42</td>
<td>75</td>
<td>234</td>
</tr>
</tbody>
</table>
came to endarterectomy. This patient had already had a subsequent stroke after the TIA. Three patients had occlusions, 2 of whom had progressed from TIA to stroke. All occlusions involved major neck vessels.

**Attacks Lasting 1 Day to 3 Weeks**

Forty-two patients recovered completely after an initial episode which lasted between 1 and 21 days. These were thus reversible ischemic neurological deficits (RINDs). Thirty-six were carotid and 6 VB. Ten patients in this group had a clinical history, examination findings, hypertension and/or CT scan findings consistent with a lacunar lesion.

Sixteen patients (38%) had subsequently had a second episode lasting longer than 24 hours. Of these, 9 were carotid; 10 of the 16 were in the same territory as the initial stroke. Eleven suffered the second attack within 6 months of the first, 3 between 6 and 12 months and 2 after 1 year.

Eight had bruits of which 5 were carotid. Only 2 of these had angiograms; 1 of them had an appropriate stenosis, while in the other the internal carotid was occluded.

Twenty-one patients (50%) had CT scans: infarcts were seen in 11. Atrophy was seen in 2. Twenty-three (55%) had angiography. Three had a stenosis and 4 patients showed vessel occlusions; 2 of these were peripheral and 2 affected the carotid artery. Two (9%) of the patients who had angiograms came to endarterectomy; one of these had a bruit and both had suffered two ischemic episodes lasting more than 24 hours.

The mean blood pressure in this group was similar to that in the other groups. Furthermore, the number of patients with a history of hypertension was similar in all groups.

**Attacks Lasting Longer Than 3 Weeks**

There were 75 patients in this group of whom 57 had carotid and 18 VB episodes. Sixteen patients in this group had evidence of a lacunar lesion. Seventeen (23%) subsequently had a second episode lasting longer than 24 hours. Of these 11 were carotid; 12 of the 16 had their second episode in the same territory as the initial episode. Five suffered the second attack within 6 months, 5 between 6 months and 1 year and 7 after 1 year.

Eight patients in this group had bruits of which 7 were carotid. Two of these had angiograms but neither showed a stenotic lesion; I showed an internal carotid kink and the other mild atheroma only.

CT scans were obtained in 42 patients (56%): infarcts were seen in 20.

Thirty-four of 75 (45%) had angiograms. Seven showed a stenosis and 6 showed occlusions of which 4 were branch and 2 carotid.

Five patients came to endarterectomy. None of these had bruits. Three had had more than one stroke and 2 a single stroke. All had blood pressure greater than 140/90 and 2 had intermittent claudication.

**Carotid Stenosis**

To discover clinical features which make it more likely a stenosis will be found on angiography, a number of factors were examined. Twenty-five of the 87 patients over 50 years of age, as against 5 of 38 under this age, had a carotid stenosis. This difference, though suggestive, did not reach statistical significance.

Twenty-one of the 30 patients (70%) with carotid stenosis had a blood pressure exceeding 140/90 mm Hg as against 46 of the 95 (48%) without stenosis. This difference just failed to reach the 5 per cent level of significance. However, a carotid bruit and intermittent claudication were both significantly associated with carotid stenosis. Fourteen of the 30 patients (47%) with stenosis had a carotid bruit compared with only 8 of the 87 patients (9%) without stenosis (modified \( \chi^2 = 20.4 \) \( p < 0.001 \)). Eight of the 30 patients with stenosis (27%) had intermittent claudication compared to 6 of the 95 (6%) without stenosis (modified \( \chi^2 = 7.56 \) \( p < 0.01 \)).

**Discussion**

This paper has analyzed the natural history of 234 patients who made a complete or almost complete recovery from their initial vascular episode. Attention was directed toward the influence of the duration of the initial attack on natural history, prognosis and findings on investigation.

The data suggest that there is no difference as far as pathogenesis is concerned between TIA attacks lasting less than 24 hours and those lasting longer. There is, however, a difference in the degree of risk of a subsequent stroke. Of all patients who suffered a TIA lasting less than 24 hours 38% went on to develop a stroke. This figure is similar to the consensus from the literature.\(^1\) However, concerning those whose initial episode lasted less than 5 minutes, no less than 51 per cent subsequently had a stroke. In contrast, only 28% of patients with an initial episode lasting longer than 24 hours but recovering later, had a second stroke from which they did not recover. It should be noted that follow up was shorter in those whose attacks lasted more than 24 hours. Similar results have been reported by others.\(^6\) A higher incidence of short lived TIAS progressing to stroke has also been shown by Friedman et al.,\(^9\) although their definition of short lived TIAS was up to 1 hour. It should also be noted that in our series 14% of strokes were followed by transient ischemic episodes.\(^16\)

Carotid stenosis was more likely to be discovered in patients with short lived TIAs.\(^11\) In the group as a whole, bruits were the most reliable clinical indicator of stenosis. We also found the incidence of peripheral vascular disease to be significantly increased in those who had carotid stenosis.\(^13\) Hypertension and age, while suggestive, were not significantly different.

The yield from angiography was high in those whose attacks lasted less than 30 minutes. Thirteen patients (27%) who had angiography came to surgery.
In attacks lasting longer than this, the number of patients coming to endarterectomy was smaller. However it was not negligible. Furthermore, in 5 patients who recovered after 3 weeks an operable stenotic lesion was found. None of these 5 had a bruit. Three had had more than one stroke and 2 only one stroke. This emphasizes that in patients whose attacks last longer than 30 minutes, a large number of angiograms were needed to pick up the small number with stenosis.

Out of 77 patients who had angiograms, 8 (10%) came to endarterectomy. This reinforces the need for accurate non-invasive methods to help decide which patients, who recover from attacks lasting more than 30 minutes, should have angiography. Overall, 21 patients had endarterectomies performed: this represents 17% of those who came to angiography, compared with 30 patients in whom a carotid stenosis was demonstrated at angiography. The reason for not operating on 9 patients was varied but, in the majority, operation was not possible because of the site of the stenosis or widespread nature of the atheroma.

It is important to note that in the 13 patients with initial attacks lasting less than 30 minutes who came to endarterectomy, 7 had already progressed to a further separate episode lasting more than 24 hours: they had already subsequently had a stroke after the TIA. Operation was performed because they had made a good recovery from the stroke and were considered to be at risk from a further episode. The mere fact that a person had already subsequently had a stroke after the TIA does not signify that an operable lesion will no longer be found.

The number of abnormal CT scans in patients with episodes lasting more than 24 hours is less than that normally quoted for strokes.1 This is partly because not all CT scans were performed in the acute phase and partly because the lesion is likely to be smaller in our group of patients in whom the primary criteria was that they should have made a complete or almost complete recovery.

The main reason for investigating patients with an initial ischemic episode is to find those who are likely to proceed to a further and perhaps more devastating event. The duration of the first episode is of some help in this respect, shorter episodes carrying a greater risk. Investigation involves first seeking any medical cause which may predispose to stroke. It also aims to find those patients with stenosis who may respond to surgery. Angiography reveals lesions which are amenable to surgery in a high percentage of cases in which the initial TIA lasts less than 30 minutes. However, stenoses are still found in those in whom the initial attack has lasted longer than 3 weeks. In any attack lasting longer than 30 minutes, the reward from angiography is smaller and must be balanced against the risk of this procedure and surgery. Unfortunately, clinical criteria did not permit that small number to be identified in advance.

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References

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