CT/CT Angiography and MRI Findings Predict Recurrent Stroke After Transient Ischemic Attack and Minor Stroke
Results of the Prospective CATCH Study

Shelagh B. Coutts, MD; Jayesh Modi, MD; Shiel K. Patel, BSc; Andrew M. Demchuk, MD; Mayank Goyal, MD; Michael D. Hill, MD; for the Calgary Stroke Program

Background and Purpose—Transient ischemic attack and minor stroke portend a substantial risk of recurrent stroke. MRI can identify patients at high risk for a recurrent stroke. However, MRI is not commonly available as an emergency. If similarly clinically predictive, a CT/CT angiographic (CTA) imaging strategy would be more widely applicable.

Methods—Five hundred ten patients with consecutive transient ischemic attack and minor stroke underwent CT/CTA and subsequent MRI. We assessed the risk of recurrent stroke within 90 days using standard clinical variables and predefined abnormalities on the CT/CTA (acute ischemia on CT and/or intracranial or extracranial occlusion or stenosis ≥50%) and MRI (diffusion-weighted imaging-positive).

Results—There were 36 recurrent strokes (7.1%; 95% CI, 5.0–9.6). Median time to the event was 1 day (interquartile range, 7.5). Median time from onset to CTA was 5.5 hours (interquartile range, 6.4 hours) and to MRI was 17.5 hours (interquartile range, 12 hours). Symptoms ongoing at first assessment (hazard ratio, 2.2; 95% CI, 1.02–4.9), CT/CTA abnormalities (hazard ratio, 4.0; 95% CI, 2.0–8.5), and diffusion-weighted imaging positivity (hazard ratio, 2.2; 95% CI, 1.05–4.7) predicted recurrent stroke. In the multivariable analysis, only CT/CTA abnormalities predicted recurrent stroke. In a secondary analysis, CT/CTA and MRI were not significantly different in their discriminative value in predicting recurrent stroke (0.67; 95% CI, 0.59–0.76 versus 0.59; 95% CI, 0.52–0.67; P=0.09).

Conclusions—Early assessment of the intracranial and extracranial vasculature using CT/CTA predicts recurrent stroke and clinical outcome in patients with transient ischemic attack and minor stroke. In many institutions, CTA is more readily available than MRI and physicians should access whichever technique is more quickly available at their institution. (Stroke. 2012;43:1013-1017.)

Key Words: CT angiography ■ minor stroke ■ MRI ■ recurrent stroke ■ transient ischemic attack

There are approximately half a million patients who present with transient or mild focal neurological symptoms every year in North America alone. Approximately 15% to 30% of disabling strokes are heralded by nondisabling transient ischemic attacks (TIAs) or minor strokes, commonly within the 7 days preceding stroke. After a TIA or minor stroke, there is an estimated 10% risk of recurrent stroke within 90 days. With the majority of these recurrent strokes occurring within 48 hours of their TIA, there is a need to identify the highest risk patients urgently to implement appropriate early treatments. Imaging is 1 potential way to stratify the risk of recurrent stroke. A substantial proportion of patients with TIA and minor stroke have ischemic injury observed on diffusion-weighted imaging (DWI). The presence of an acute DWI lesion or an intracranial occlusion identifies patients with TIA and minor stroke at increased risk of recurrent stroke. Furthermore, almost 50% of patients with TIA with acute DWI lesions have evidence of an extracranial or intracranial large artery occlusion or stenosis suggesting that vascular imaging is a critical factor. Finally, we infer that the clinical distinction between TIA and minor ischemic stroke is largely irrelevant, particularly when the assessment occurs before 24 hours have elapsed preventing a clear application of the World Health Organization clinical definition of TIA. Multislice helical CT scanners with CT angiography (CTA) capability are widely available in many emergency departments. CTA uses the administration of intravenous contrast media to assess the intracranial and extracranial vasculature with high spatial resolution. The addition of CTA adds <5 minutes to a standard CT of the brain and can be safely completed in most patients.
that an intracranial arterial occlusion identified by CTA is an independent predictor of poor outcome in patients with acute stroke and TIA. Furthermore, large artery disease is readily identifiable on CTA and is the stroke mechanism with the highest risk of early stroke recurrence.

We hypothesized that with the fast assessment of the intracranial and extracranial vasculature, CTA could predict recurrent stroke in patients with TIA and minor stroke. We secondarily sought to compare prediction of recurrent stroke with CT/CTA compared with acute DWI.

Methods

Consecutive patients aged at least 18 years presenting with a high-risk TIA focal weakness or speech disturbance lasting ≥5 minutes or minor ischemic stroke (National Institute of Health Stroke Scale score ≤3) who were referred to the stroke team at Foothills Medical Centre were prospectively considered for enrollment. Patients were examined by a stroke neurologist and had a CT brain and CTA of the circle of Willis and neck within 24 hours of symptom onset. Most patients had a stroke MRI completed. Exclusion criteria included pre- or post-morbid modified Rankin Scale ≥2, acute treatment with a thrombolytic drug, or a serious comorbid illness that would likely result in death within 3 months. The local institutional ethics committee approved this protocol and patients provided written informed consent. Detailed baseline clinical and outcome information was prospectively collected for each patient.

Baseline Imaging and Interpretation

All CT imaging was performed on a Siemens 64-slice scanner. Standard whole brain axial CT was performed with a sequential (nonhelical) technique at 5-mm slice thickness. CT was immediately followed by CTA from the aortic arch to skull vertex with a helical scan technique at 0.6 mm thickness using 75 to 100 mL contrast bolus injected into the antecubital vein at 3 to 5 mL/s. CTA source images were reformatted into thin 3-mm sagittal, coronal, and axial images and thick 24-mm axial maximum intensity projection slabs for the intracranial circulation and 3-mm oblique sagittal section through the carotid bifurcations. MRIs were completed on either a GE 3-T scanner or a Siemens 1.5-T MR scanner. All imaging was assessed by a neuroradiologist who remained blinded to the results of the other imaging modality and was given information regarding the clinical symptoms only. CT was assessed for the presence of any acute ischemia. CTAs were assessed for the presence of any symptomatic intracranial or extracranial occlusion or stenosis ≥50%. The severity of extracranial stenosis was calculated using the standard North American Symptomatic Carotid Endarterectomy Trial (NASCET) method applied to reformatted axial CTA images. Intracranial stenosis was measured in a similar manner and vessels were fully assessed as distal as was technically possible. A priori we chose the following CT/CTA parameters to define a high risk phenotype of CT/CTA (CT/CTA-positive metric): acute ischemic change seen on CT or intracranial or extracranial vessel occlusion or stenosis ≥50% ipsilateral to the clinically relevant ischemic brain tissue. MRI was assessed for acute or hyperacute lesions on DWI (DWI-positive) using axial DWI, apparent diffusion coefficient, and fluid-activated inversion recovery sequences.

Patient Outcomes

Patients received routine clinical care including antihypertensive and lipid-lowering therapy at the discretion of the treating physician. Patients whose symptoms resolved within 24 hours of onset were classified as TIA; those with symptoms persisting >24 hours, even if minor, were classified as ischemic stroke. At the time of the 90-day follow-up, the treating physician rated the stroke mechanism and modified Rankin Scale. Recurrent stroke was defined as a functional deterioration in neurological status of vascular origin lasting >24 hours or a new sudden focal neurological deficit of vascular origin lasting at least 24 hours (that was not felt to be a recurrent event) with CT/CTA compared with acute DWI.

Statistical Analysis

Statistical analysis was completed with Stata (Version 11). The primary outcome was the first recurrent stroke event within 90 days. The risk of recurrent stroke was assessed using standard clinical variables and predefined abnormalities on the CT/CTA at risk metric. For the primary outcome, univariable analysis was conducted using a simple Cox proportional hazards model. A multivariable Cox proportional hazard model was developed using predefined variables that were chosen either from statistically significant results from the univariable analysis or that had been previously shown to predict recurrent stroke as part of the ABCD² score. Variables were removed in a stepwise fashion if not predictive of recurrent stroke. The proportional hazards assumption was tested and found to be valid. To allow the direct comparison of CT/CTA and DWI MRI for the secondary analysis, missing MRI results were imputed using a multiple imputation based on a previously published meta-analysis of predictors of DWI positivity. This included motor or speech symptoms, atrial fibrillation, symptomatic carotid stenosis ≥50%, and symptom duration >60 minutes. A logistic regression model predicting DWI positivity was created. Predicted values from this equation were generated and the probability threshold corresponding to the point of maximization of sensitivity and specificity of the model was chosen to define a DWI-positive or -negative imputation result. A secondary analysis to compare the accuracy of prediction of recurrent stroke with CT/CTA and DWI MRI was then completed using receiver operator characteristic curves.

Results

Over a period of 29 months, 510 patients were enrolled of whom 491 (96.3%) were admitted to the hospital. Median

Table 1. Baseline Characteristics Stratified by CT/CTA-Positive Metric (Acute Ischemia on CT, Extracranial or Intracranial CTA Occlusion, or Stenosis ≥50%)

<table>
<thead>
<tr>
<th>Variable</th>
<th>CT/CTA-Positive, % (no./No.)</th>
<th>CT/CTA-Negative, % (no./No.)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≥60 y</td>
<td>76 (133/174)</td>
<td>66 (221/336)</td>
<td>0.015</td>
</tr>
<tr>
<td>Female sex</td>
<td>39 (68/174)</td>
<td>42 (140/336)</td>
<td>0.63</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>15 (26/174)</td>
<td>15 (51/336)</td>
<td>1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>58 (101/174)</td>
<td>55 (184/336)</td>
<td>0.51</td>
</tr>
<tr>
<td>Current smoker</td>
<td>17 (30/174)</td>
<td>15 (49/336)</td>
<td>0.44</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>6 (11/174)</td>
<td>7 (25/336)</td>
<td>0.72</td>
</tr>
<tr>
<td>Ongoing symptoms at first assessment</td>
<td>70 (121/174)</td>
<td>57 (192/336)</td>
<td>0.007</td>
</tr>
<tr>
<td>Systolic blood pressure ≥140 mm Hg</td>
<td>72 (126/174)</td>
<td>75 (250/336)</td>
<td>0.67</td>
</tr>
<tr>
<td>Glucose &gt;8 mmol/L</td>
<td>18 (31/172)</td>
<td>14 (46/332)</td>
<td>0.24</td>
</tr>
<tr>
<td>Aspirin treatment*</td>
<td>87 (151/173)</td>
<td>84 (283/335)</td>
<td>0.28</td>
</tr>
<tr>
<td>Clopidogrel treatment*</td>
<td>46 (80/173)</td>
<td>27 (91/335)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Combined aspirin and clopidogrel treatment*</td>
<td>42 (72/173)</td>
<td>23 (78/334)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Statin treatment*†</td>
<td>73 (125/172)</td>
<td>53 (177/334)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

CTA indicates CT angiography.
All drug treatments refer to whether the patient was either started on the drug or continued on it (if previously on it) when assessed in the emergency room for this event.
†Statin treatment refers to use of any statin agent at any dose.
Secondary to other nonvascular factors: drugs, fever, infection. A panel of 3 physicians, which included 2 stroke neurologists (S.B.C. and A.M.D.) and a neuroradiologist (M.G.), reviewed and adjudicated the imaging and clinical information on any patient with a recurrent stroke.
Table 2. The Effect of Various Clinical and Imaging Parameters on Recurrent Stroke

<table>
<thead>
<tr>
<th>Variable</th>
<th>Recurrent Stroke, % (no./No.)</th>
<th>No Recurrent Stroke, % (no./No.)</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age ≥60 y</td>
<td>81 (29/36)</td>
<td>69 (321/463)</td>
<td>1.8 (0.8–4.0)</td>
</tr>
<tr>
<td>Female sex</td>
<td>47 (17/36)</td>
<td>41 (189/463)</td>
<td>1.3 (0.7–2.5)</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>22 (8/36)</td>
<td>15 (68/463)</td>
<td>1.6 (0.7–3.5)</td>
</tr>
<tr>
<td>Hypertension</td>
<td>61 (22/36)</td>
<td>56 (259/463)</td>
<td>1.2 (0.6–2.4)</td>
</tr>
<tr>
<td>Current smoker</td>
<td>11 (4/36)</td>
<td>16 (72/463)</td>
<td>0.7 (0.3–2.0)</td>
</tr>
<tr>
<td>Transient ischemic attack or stroke in the preceding 7 d</td>
<td>0 (0/36)</td>
<td>8 (36/463)</td>
<td>...</td>
</tr>
<tr>
<td>Systolic blood pressure ≥140 or diastolic ≥90 mm Hg</td>
<td>78 (28/36)</td>
<td>73 (340/463)</td>
<td>1.2 (0.6–2.7)</td>
</tr>
<tr>
<td>Glucose &gt;8 mmol/L</td>
<td>17 (6/36)</td>
<td>15 (68/457)</td>
<td>1.1 (0.5–2.7)</td>
</tr>
<tr>
<td>Ongoing symptoms at first assessment</td>
<td>78 (28/36)</td>
<td>60 (279/463)</td>
<td>2.2 (1.02–4.9)</td>
</tr>
<tr>
<td>Motor weakness</td>
<td>69 (25/36)</td>
<td>64 (295/463)</td>
<td>1.3 (0.6–2.6)</td>
</tr>
<tr>
<td>Speech disturbance without weakness</td>
<td>22 (8/36)</td>
<td>31 (145/463)</td>
<td>0.64 (0.3–1.4)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Yes (n No)</th>
<th>No (n)</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspirin treatment*</td>
<td>95 (34/36)</td>
<td>84 (391/463)</td>
<td>3.0 (0.7–12.7)</td>
</tr>
<tr>
<td>Clopidogrel treatment*</td>
<td>39 (14/36)</td>
<td>33 (152/463)</td>
<td>1.3 (0.7–2.5)</td>
</tr>
<tr>
<td>Combined aspirin and clopidogrel treatment*</td>
<td>36 (13/36)</td>
<td>28 (133/463)</td>
<td>1.4 (0.7–2.7)</td>
</tr>
<tr>
<td>Statin treatment†</td>
<td>66 (24/36)</td>
<td>59 (274/463)</td>
<td>1.3 (0.7–2.7)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Imaging findings</th>
<th>Yes (n No)</th>
<th>No (n)</th>
<th>Hazard Ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intracranial or extracranial vessel occlusion, ≥50%</td>
<td>14 (5/36)</td>
<td>12 (56/463)</td>
<td>1.2 (0.5–3.0)</td>
</tr>
<tr>
<td>Extracranial carotid occlusion or stenosis ≥50%</td>
<td>56 (20/36)</td>
<td>18 (64/463)</td>
<td>5.1 (2.6–9.9)</td>
</tr>
<tr>
<td>CT/CTA angiography-positive metric</td>
<td>27 (14/36)</td>
<td>6 (38/463)</td>
<td>6.1 (3.1–11.9)</td>
</tr>
<tr>
<td>Diffusion-weighted imaging-positive</td>
<td>19 (7/36)</td>
<td>9 (40/463)</td>
<td>2.4 (1.05–5.5)</td>
</tr>
</tbody>
</table>

All described findings are of the presumed symptomatic vessel. CT/CTA-positive metric is a composite of CT/CTA findings including: acute stroke on CT, intracranial or extracranial vessel occlusion, or ≥50% stenosis. CTA indicates CT angiography.

*All drug treatments refer to whether the patient was either started on the drug or continued on it (if previously on it) when assessed in the emergency room for this event.
†Statin treatment refers to use of any statin agent at any dose.

Eleven patients (2.2%) were lost to follow-up and 5 patients (1%) died during the 90-day follow-up period. In 88% of patients, the follow-up was completed in person; the remainder was completed by telephone. In 92% of patients, the final diagnosis was ischemic stroke (237 patients) or TIA (232 patients). The principal alternate final diagnoses included migraine (n = 14), somatoform disorder (n = 7), seizure (n = 3), and other (n = 17). Eighty-five percent of patients were treated with aspirin for >1 day (and 100% of patients received at least 1 dose of an antiplatelet agent in the emergency department), 34% with clopidogrel (including 29% on both aspirin and clopidogrel), and 60% with a statin. Twenty-nine patients (6%) underwent carotid revascularization with a median time from onset to carotid artery stenting of 6 days and to carotid endarterectomy of 8 days. There were no recurrent events as a result of carotid revascularization.

There were 36 primary outcome events (36 of 510 [7.1%]; 95% CI, 5.0–9.6). Of these, 19 (53%) events were considered progression of the presenting event and 17 distinct recurrent strokes. Nineteen of 36 (53%) recurrent events resulted in disability on the modified Rankin Scale (≥2) at the time of 90-day follow-up. Median time to recurrent event was 1 day (interquartile range, 7.5 days). Table 2 shows that the predictors of recurrent stroke were: ongoing symptoms on first assessment, intracranial artery occlusion or stenosis ≥50%, intracranial occlusion, extracranial carotid stenosis ≥50%, DWI MRI, and the combined CT/CTA-positive metric. Treatment with aspirin, clopidogrel, aspirin and clopidogrel, or...
Figure 2. Kaplan-Meier survival free from recurrent stroke stratified by DWI-positive MRI. The upper curve represents those who were DWI-positive and the bottom those who were DWI-negative. The shaded area represents 95% confidence limits around the line with red surrounding the DWI-positive group and blue surrounding the DWI-negative group. Log-rank test for equality of survivor functions for DWI MRI ($P=0.03$). DWI indicates diffusion-weighted imaging.

Statin was not protective. In only 1 recurrent stroke was the presence of an acute stroke on CT the only positive component in the CT/CTA-positive metric. In the multivariable analysis, only the CT/CTA-positive metric remained predictive of recurrent stroke. Analysis including only patients with a final diagnosis of TIA or ischemic stroke did not result in substantive change to either of the results. Figures 1 and 2 illustrate the risk of recurrent stroke stratified by CT/CTA-positive metric and by DWI MRI. The risk of a new event in patients with CT/CTA-positive metric was not affected by stratifying by DWI positivity. The reverse was also true. There was heterogeneity in the risk of recurrent stroke based on the final Trial of ORG 10172 in Acute Stroke Treatment (TOAST) classification derived at 90-day follow-up: large artery disease, 8 of 71 (11%); cardioembolic, 10 of 91 (11%); small vessel disease, 9 of 45 (20%); cryptogenic, 8 of 232 (3%); and other, 1 of 19 (5%; $P<0.001$).

Diagnostic accuracy of the CT/CTA-positive metric and DWI MRI is shown in Table 3. Using receiver operating characteristic analysis, CT/CTA and MRI were not significantly different in their discriminative value in predicting recurrent stroke (0.67; 95% CI, 0.59–0.76 versus 0.59; 95% CI, 0.52–0.67; $P=0.09$).

### Discussion

Early assessment of the intracranial and extracranial vasculature using CT/CTA predicts recurrent stroke and clinical outcome in patients with TIA and minor stroke. We found that the presence of a symptomatic intracranial or extracranial severe arterial stenosis or occlusion was predictive of recurrent stroke.

Previous work has shown that much of the risk of recurrent stroke in TIA and minor stroke is front-loaded with the highest risk period being in the first 48 hours from symptom onset. The median time to event in our study was 1 day with immediate separation of the survival curves followed by a gradual separation at later time points (Figure 1). Therefore, assessment of these patients at later time points misses those at the highest risk.

The ideal screening imaging modality would be quick and available 24 hours a day, 7 days a week in most emergency departments. The median time from symptom onset to CTA was just >5 hours in this study demonstrating that acute CT/CTA imaging can be done very quickly. We were much slower in getting access to MRI, which is both a potential limitation of this work and a reality for many institutions.

This study is unique because of the rigorous early clinical and imaging subject assessments. One reason for the usefulness of CT is that intracranial stenoses or occlusions can occur from both intrinsic atherosclerotic disease and cardio- or atheroembolic disease. Because patients with cardioembolic stroke and many with large artery disease have proven treatments that could be implemented immediately, this has direct clinical relevance. An important caveat to using CTA in the immediate care of these patients is that for small vessel disease, some of these patients are at risk of symptom progression, which cannot be identified using CTA. Extracranial carotid disease was not a major predictor of recurrent stroke in this data set. We suspect that this was because of early definitive treatment. The importance of abnormalities in the intracranial vasculature as shown in this study illustrates the need for more comprehensive imaging of both the intracranial and the extracranial vessels. Future work should include assessment of nonstenotic ulcerated plaque or other plaque characteristics and perfusion imaging as potential markers of increased risk. At our institution, many CT/CTA-positive patients were treated with early dual antiplatelet therapy (Table 1). A pilot study suggested that this treatment may be beneficial but this remains unproven. Randomized controlled trials of more aggressive treatments must be implemented if identification of high-risk patients is to make any difference in patient outcomes. We have also started using a normal CT/CTA to identify patients who can be investigated as an outpatient rather than being admitted to the hospital. This approach also needs further investigation.

We included patients very early into their presentation at a time when distinctions of TIA or minor stroke cannot be made. Assessment at this early time point makes comparisons with published experience of cohorts examined later in their

### Table 3. Accuracy of CT/CTA and DWI MRI in Predicting Recurrent Stroke

<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>CT/CTA-positive metric</td>
<td>67% (49–81, 2436)</td>
<td>68% (64–72, 316/463)</td>
<td>14% (9–20, 24171)</td>
<td>96% (94–98, 316/328)</td>
</tr>
<tr>
<td>DWI-positive</td>
<td>75% (57–88, 2736)</td>
<td>43% (39–48, 201/463)</td>
<td>9% (6–13, 27289)</td>
<td>96% (92–98, 201/210)</td>
</tr>
</tbody>
</table>

Results are shown as percent (95% CI, no./No.).

PPV indicates positive predictive value; NPV, negative predictive value; CTA, CT angiography; DWI, diffusion-weighted imaging.
course uncertain. Early evaluation identifies an unstable population in whom new treatments are needed. Waiting for these patients to stabilize over the next 24 hours misses the patients at highest risk. The use of motor or speech symptoms as the enrollment criterion for TIA events reflects our understanding of the benign nature of isolated transient sensory events. However, these results cannot therefore be extrapolated to transient sensory events. A number of patients cannot or refuse to undergo MRI scanning and limiting this study only to patients who could get an MRI would bias our sample, hence our emphasis on CT/CTA. Our imputation of the DWI MRI result for a number of patients is a limitation; however, our use of imputation did not substantially change the conclusion, only the precision of the point estimate.

Using CT/CTA to assess patients with TIA and minor stroke is a practical solution to assessment of these patients and has the potential to benefit many people worldwide. Adoption of CT/CTA into clinical practice for the assessment of patients with TIA and minor stroke identifies a high-risk group suitable for aggressive acute stroke prevention treatment. Randomized controlled trials of treatment options in these high-risk patients with minor stroke and TIA are urgently needed.

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References
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CT/CT血管造影およびMRIの結果は一過性脳虚血発作および軽症脳卒中後の脳卒中再発を予測する—前向きCATCH試験の結果

CT/CT Angiography and MRI Findings Predict Recurrent Stroke After Transient Ischemic Attack and Minor Stroke — Results of the Prospective CATCH Study

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背景および目的：一過性脳虚血発作および軽症脳卒中は、脳卒中を再発するリスクがかなり高いことを予測する。MRIによって脳卒中再発の高リスク患者の特定が可能である。しかしMRIは通常、緊急では利用できない。同様に臨床的予測が可能であれば、CT/CT血管撮影（CTA）はより広く適用可能である。

方法：一過性脳虚血発作および軽症脳卒中を発症した連続510例の患者にCT/CTAを、次いでMRIを実施した。基準的な臨床変数および予め定義されたCT/CTA上の異常（急性虚血または頭蓋内もしくは頭蓋外の閉塞または20%の狭窄）およびMRI上の拡散強調画像陽性（ハザード比=2.2, 95%CI:1.02 ~ 4.9）は、脳卒中の再発を予測した。

結果：36例の脳卒中が再発した(7.1%, 95%CI:5.0 ~ 9.6)。イベントまでの期間の中央値は1日（四分位範囲：7.5）。発症からCTAまでの時間の中央値は5.5時間（四分位範囲：6.4時間）。MRIまでの時間の中央値は17.5時間（四分位範囲：12時間）であった。初回評価時に進行中の症状（ハザード比＝2.2, 95%CI:1.02 ~ 4.9）、CT/CTA上の異常（ハザード比＝4.9, 95%CI:2.0 ~ 8.5）および拡散強調画像陽性（ハザード比＝2.2, 95%CI:1.05 ~ 4.7）は、脳卒中の再発を予測した。多変量解析では、CT/CTA異常のみが脳卒中再発を予測した。副次解析では、CT/CTAおよびMRIの脳卒中再発予測に対する識別能に有意差は認められなかった(0.67, 95%CI:0.59 ~ 0.76に対し0.59, 95%CI:0.52 ~ 0.67, p = 0.09)。

結論：一過性脳虚血発作および軽度脳卒中の患者において、CT/CTAを用いた頭蓋内および頭蓋外血管系の早期評価は、脳卒中の再発と臨床的転帰を予測する。多くの施設で、CTAはMRIよりも利用しやすい。医師は各自の施設で、速やかに利用可能ないずれかの検査技術を利用すべきである。

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図1

CT/CTA評価基準によって層別化した脳卒中再発的Kaplan-Meier生存曲線。上側の曲線はCT/CTA評価基準陽性を、下側の曲線はCT/CTA評価基準陰性を示す。網掛け部分は、曲線周囲の95%信頼区間を示す。赤色の囲みはCT/CTA陰性群、青色の囲みはCT/CTA陽性群である。CT/CTAに関する生存関数の同様性のログランク検定(p < 0.0001)。CTA:CT血管造影。

図2

DWI陽性MRIによって層別化した脳卒中再発前のKaplan-Meier生存曲線。上側の曲線はDWI陽性を、下側の曲線はDWI陰性を示す。網掛け部分は、曲線周囲の95%信頼区間を示す。赤色の囲みはDWI陽性群、青色の囲みはDWI陰性群である。DWI MRIに関する生存関数の同様性のログランク検定(p = 0.03)。DWI:拡散強調画像。