Perfusion MRI Abnormalities in Speech or Motor Transient Ischemic Attack Patients

Andrea L. Krol; Shelagh B. Coutts, MBChB; Jessica E. Simon, MBChB; Michael D. Hill, MD; Chul-Ho Sohn, MD; Andrew M. Demchuk, MD; for the VISION Study Group

Background and Purpose—Transient ischemic attack (TIA) patients may deteriorate rapidly. MRI is being increasingly used to assess such patients. One possible mechanism of neurological worsening is the presence of perfusion abnormalities. We sought to identify what proportion of TIA patients had evidence of perfusion abnormalities on MRI.

Methods—TIA patients were prospectively enrolled and had a MRI completed as soon as possible. The images were assessed for the presence of perfusion abnormalities.

Results—Sixty-nine TIA patients were enrolled, and 62 had perfusion imaging. In 56 patients (81%), the symptoms had resolved before imaging. In 21 patients (33.9%), there was evidence of a perfusion abnormality defined by relative mean transit time delay. In 12 patients (19.4%), the perfusion abnormality was present despite having complete resolution of neurological symptoms. We found no relationship between the presence of a perfusion abnormality and the clinical outcome.

Conclusions—A proportion of TIA patients have perfusion abnormalities evident on MRI. (Stroke. 2005;36:2487-2489.)

Key Words: acute stroke ■ MRI ■ transient ischemic attack

Diffusion weighted imaging (DWI) is important in the diagnosis of ischemic stroke patients. Currently, the definition of transient ischemic attack (TIA) is a sudden onset of neurological symptoms that are of vascular etiology and resolve within 24 hours. However, many patients with TIA have injury observed on DWI imaging.1–4 The assumption that TIAs are associated with complete resolution of brain ischemia leaving no permanent brain injury5,6 is false. There is growing evidence that TIA is not a benign condition and that the risk of a subsequent stroke is high within the first 48 hours7 of symptom onset.

Perfusion weighted imaging (PWI) using gadolinium-based dynamic-susceptibility contrast provides information on ischemia. In this prospective study, we sought to understand whether MRI perfusion abnormalities exist among TIA patients despite the rapid resolution of symptoms.

Methods

Patients who were prospectively enrolled with hemiparesis or aphasia that resolved within 24 hours were examined within 12 hours of onset, were independent on the modified Rankin scale, and were ≥18 years of age. Images were obtained using a 3-T scanner. The PWI was acquired using dynamic susceptibility contrast imaging. Imaging was assessed by a neuroradiologist blind to clinical information except the symptom side. Images were examined for the presence of an acute DWI lesion, for an occlusion on intracranial magnetic resonance angiography (MRA), and for a perfusion delay on the mean transit time (MTT) map.

Patients were assessed with the National Institutes of Health Stroke Scale at 24 hours and with the modified Rankin scale at 3 months. The potential mechanism assigned using the Trial of Org 10172 in Acute Treatment classification and any recurrent strokes were recorded.

The association between the presence or absence of a relative MTT delay (PWI lesion) and baseline characteristics was assessed. Logistic regression modeling using backward elimination was used to identify the predictors of a perfusion abnormality.

Results

Sixty-nine TIA patients were enrolled. The median duration of symptoms was 90 minutes (range, 5 to 1380 minutes). Twenty-seven patients were women (39%). In 56 of the patients (81%), the symptoms had resolved by the beginning of the MRI. Thirty-two patients (46.4%) had evidence of a DWI hyperintensity.

In 7 patients (10.1%), the PWI sequence was not completed or was not interpretable because of technical difficulty. These patients were excluded from additional analysis. In 21 patients (33.9%), there was evidence of a delay in the MTT map (Tables 1 and 2). The mean time to MRI scan was 9.2 hours in patients with a PWI lesion and was 13.6 hours in patients without a PWI lesion (P=0.04). At the time of MRI,
TABLE 1. Comparison of Clinical Factors in Patients with PWI Lesions and Those Who Do Not Have Evidence of PWI Lesion (Univariable Analysis)

<table>
<thead>
<tr>
<th>Variables</th>
<th>PWI Lesion (n=21)</th>
<th>No PWI Lesion (n=41)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean, SD)</td>
<td>69 (12)</td>
<td>66 (12)</td>
<td>0.25</td>
</tr>
<tr>
<td>Male gender</td>
<td>52%</td>
<td>61%</td>
<td>0.59</td>
</tr>
<tr>
<td>NIHSS (median)</td>
<td>0 (0–1)</td>
<td>0 (0–0)</td>
<td>0.07*</td>
</tr>
<tr>
<td>Onset-to-MRI time (median, interquartile range)</td>
<td>356 (184–811)</td>
<td>725 (342–1285)</td>
<td>0.03*</td>
</tr>
<tr>
<td>Internal carotid artery stenosis &gt;50%</td>
<td>14%</td>
<td>2%</td>
<td>0.11</td>
</tr>
<tr>
<td>Symptoms resolved before beginning of MRI</td>
<td>57%</td>
<td>95%</td>
<td>0.001</td>
</tr>
<tr>
<td>Any intracranial occlusion</td>
<td>48%</td>
<td>10%</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Variables (blood pressure, serum glucose, diabetes mellitus, etc) that were not significant at P<0.05 are not shown.
*Mann–Whitney U test.

12 patients (19.4%) had complete resolution of neurological symptoms, yet still had perfusion abnormalities (Figure).

In a multivariable model adjusting for age and time from onset to MRI, occlusion was the most important predictor of PWI lesion (P=0.001). However, the time to MRI was a predictor of the presence of PWI lesion (P=0.039). Patients with shorter onset to MRI times were more likely to show PWI abnormalities.

Nearly all of the patients (66 of 69, 95%) had a modified Rankin score of 0 or 1 at 3 months. Of the 3 patients who had a modified Rankin score >1, all had resolved by the time of the MRI scan, but 2 had a persistent PWI abnormality. Two of these patients had recurrent strokes (1 who had a PWI abnormality and 1 who did not).

Discussion

We found that, despite many patients having transient symptoms, a proportion of motor or speech TIA patients have perfusion abnormalities evident on MRI. Patients with shorter onset to MRI times were also more likely to show PWI abnormalities. We found no relationship of perfusion abnormalities to clinical outcome. The only factor predictive of a perfusion abnormality in a multivariable analysis was the presence of a vessel occlusion on MRA.

Similar to our results, a recent study8 found that 32% of TIA patients had evidence of an MRI perfusion abnormality. We found that nearly all of the patients had an excellent outcome. A possible reason for good outcomes in this study is that all of the patients were admitted to the hospital. If there was a clinical deterioration before 24 hours, then these patients would not be classified as a TIA. Importantly, a discord between the clinical resolution and the presence of a PWI abnormality was observed. Additional study using quantitative perfusion techniques is required to determine whether symptom resolution is associated with benign oligemia.9

The 3-T MRI may be a limitation, because it may identify more areas of perfusion abnormality than a 1.5T system; also, these results are only applicable to speech and motor TIAs, because sensory TIAs were excluded. Patients with severe carotid stenosis can have chronic MTT delays,10 and follow-up perfusion imaging would have been helpful to see if any perfusion lesions were chronic, especially in patients with no evidence of diffusion lesions. The delay to MRI was longer in patients without a PWI lesion, suggesting that our results may underestimate the proportion of TIA patients with perfusion abnormalities. Cerebral blood volume and blood flow maps were also not examined because of technical difficulties. The reader did know symptom side, which may have biased detection of perfusion abnormality. Blinded review may have resulted in fewer perfusion lesions seen.

A proportion of TIA patients have evidence of perfusion abnormalities on MRI. We did not find any relationship with clinical outcome or recurrent events.

Acknowledgments

We would like to acknowledge the VISION study group for their help with this study, including Karyn Fischer, RN, Marie McClelland, RN, Andrea Cole-Hashayne, RN, Karla Ryckborst, RN, Linda Armitage, RN, Carol Kenney, RN, Nancy Newcommon, RN, Dr Alastair Buchanan, Dr James Kennedy, Dr James Scott, Dr Philip Barber, Dr Vanessa Palumbo, Dr Jayanta Roy, Dr Tim Watson, Dr Nic Weir, Dr Siva Kumar, Dr Jean-Martin Boulanger, Dr Suresh

(A) DWI lesions shown by arrows at baseline in a TIA patient whose symptoms of left-sided weakness resolved within 30 minutes. (B) MTT abnormality at baseline. (C) Asymptomatic, hyperintense region in right middle cerebral artery territory on the fluid-attenuated inversion recovery at 30 days.

TABLE 2. No. of Patients with DWI Positive/Negative and PWI Positive/Negative Respectively, Grouped by Time to Magnetic Resonance Scanning

<table>
<thead>
<tr>
<th>Variables</th>
<th>&lt;6 h (n=23)</th>
<th>6–12 h (n=12)</th>
<th>12–24 h (n=16)</th>
<th>&gt;24 h (n=11)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DWI+, PWI+</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>DWI+, PWI−</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>DWI−, PWI+</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>DWI−, PWI−</td>
<td>9</td>
<td>7</td>
<td>9</td>
<td>5</td>
</tr>
</tbody>
</table>
Subramaniam, Dr Michael Eliasziw, Dr Richard Frayne, Dr Ross Mitchell, and Kathryn Werdal. The 3.0 T MR scanner used in this study was partially funded by the Canada Foundation for Innovation. The acute stroke imaging was supported by the Alberta Foundation for Health Research and the Canadian Institute of Health Research grant no 73-1364. S.B.C. was supported by Heart and Stroke Foundation of Canada fellowship and Alberta Heritage Foundation for Medical Research. A.M.D. was supported by the Alberta Heritage Foundation for Medical Research and Canadian Institutes for Health Research. M.D.H. was supported by Heart and Stroke Foundation of Alberta/Northwest Territories and Nunavut and Canadian Institutes for Health Research. J.E.S. was supported by a fellowship from the Alberta Heritage Foundation for Medical Research.

References
Perfusion MRI Abnormalities in Speech or Motor Transient Ischemic Attack Patients
Andrea L. Krol, Shelagh B. Coutts, Jessica E. Simon, Michael D. Hill, Chul-Ho Sohn and Andrew M. Demchuk
for the VISION Study Group

Stroke. published online October 13, 2005;
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2005 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the
World Wide Web at:
http://stroke.ahajournals.org/content/early/2005/10/13/01.STR.0000185936.05516.fc.citation

Permissions: Requests for permissions to reproduce figures, tables, or portions of articles originally published
in Stroke can be obtained via RightsLink, a service of the Copyright Clearance Center, not the Editorial Office.
Once the online version of the published article for which permission is being requested is located, click
Request Permissions in the middle column of the Web page under Services. Further information about this
process is available in the Permissions and Rights Question and Answer document.

Reprints: Information about reprints can be found online at:
http://www.lww.com/reprints

Subscriptions: Information about subscribing to Stroke is online at:
http://stroke.ahajournals.org//subscriptions/