Reliability of Clinical Diagnosis of the Symptomatic Vascular Territory in Patients With Recent Transient Ischemic Attack or Minor Stroke

Enrico Flossmann, DPhil, MRCP; Jessica N. Redgrave, MRCP; Dennis Briley, FRCP; Peter M. Rothwell, MD, PhD, FRCP

Background and Purpose—Knowledge of the vascular territory of a recent transient ischemic attack or minor stroke determines appropriate investigations and the need for territory-specific interventions such as endarterectomy and stenting. However, there are few published data on the accuracy of clinical assessment of the vascular territory.

Methods—We studied agreement of clinical diagnosis of vascular territory in consecutive patients with transient ischemic attack or minor stroke with diffusion-weighted MRI who had an acute ischemic lesion(s) in a single vascular territory (determined by a neuroradiologist). Three independent neurologists (one had seen the patients, the others had a clinical summary) diagnosed the most likely vascular territory (carotid or vertebrobasilar) for each patient blind to brain imaging.

Results—One hundred thirty-three (28.0%) of 476 patients had a high signal lesion on diffusion-weighted imaging of whom 115 (86.5%) had a minor stroke and 18 (13.5%) a transient ischemic attack. Interobserver agreement (kappa statistic) on the territory ranged from 0.46 to 0.60. The agreement with diffusion-weighted imaging was only moderate (observer 1: kappa = 0.54, 95% CI = 0.36 to 0.72; observer 2: 0.48, 0.31 to 0.64; observer 3: 0.48, 0.28 to 0.67). Only the presence of visual symptoms improved the accuracy of the vascular territory diagnosis (range of kappa: 0.63 to 0.77) but not the presence of motor, speech, or sensory symptoms. Sensitivity and specificity for the diagnosis of vertebrobasilar territory ranged between 54.2% and 70.8% and 84.4% to 91.7%, respectively.

Conclusions—The reliability of clinical diagnosis of the vascular territory is only moderate, highlighting the importance of sensitive brain imaging after transient ischemic attack or minor stroke. Further imaging-based research is required to determine the optimal clinical diagnostic criteria for classification of the vascular territory.

Key Words: diagnosis ■ diffusion-weighted imaging ■ minor ischemic stroke ■ reliability ■ TIA

The diagnosis of transient ischemic attack (TIA) or minor stroke can be difficult even for experienced neurologists. Symptoms are transient and signs are usually not persistent. The clinician often has to rely entirely on the history of the event as conveyed by the patient. Once the diagnosis of TIA or minor stroke is made, it is important to establish which vascular territory was affected to guide further investigations and treatment. This is particularly important when carotid endarterectomy is considered, because the risks and benefits of surgery largely depend on the presence of a recent symptomatic event in the territory of the stenosed vessel.1 Furthermore, the risk of subsequent strokes differs according to the vascular territory.2 However, events in the posterior circulation can sometimes cause similar symptoms as events in the anterior circulation and more specific pointers to the posterior territory such as vertigo, double vision, and ataxia are often difficult to differentiate from symptoms of nonvascular etiologies. In contrast to carotid events, in which research has been stimulated by the development of carotid endarterectomy, there has been little systematic research into the diagnosis, prognosis, and risk factors for recurrent vascular events in patients with vertebrobasilar TIA and minor stroke.

Diffusion-weighted MRI (DWI) can image small ischemic lesions with high sensitivity and specificity and thus objectively determine the affected vascular territories in patients with TIA and minor stroke.3,4 To establish the accuracy of a clinical diagnosis of vascular territory, we studied consecutive patients with TIA or minor stroke with a lesion indicative of recent ischemia on DWI. We determined the agreement between the vascular territory as visualized by DWI with the unaided clinical diagnosis.

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Methods
We studied the diagnostic accuracy of a clinical diagnosis of vascular territory in a cohort of consecutive patients attending a routine outpatient TIA clinic in a UK district general hospital from September 2000 to June 2003. All patients had been referred to the dedicated stroke clinic by their general practitioner or the hospital emergency department. All patients felt to have had at least a possible TIA had MRI of the brain including DWI unless they had specific contraindications. Patients were eligible for this study if they had a clinical diagnosis of TIA or minor nondiagnosing ischemic stroke by a vascular neurologist and also had a recent clinically relevant ischemic lesion on DWI. Stroke and TIA were defined according to World Health Organization criteria (sudden onset of neurological deficit persisting for >24 hours in case of a stroke or for <24 hours in case of a TIA). Patients who had a hemorrhagic lesion on MRI were excluded. Approval from the local ethics committee was obtained.

The clinic was conducted and data were collected by a consultant neurologist (observer 1). A detailed history was obtained from each patient with a standardized questionnaire. This included date of symptom onset, duration and type of symptoms, number of events, and details on vascular risk factors, medical history, and medication. All patients had a neurological examination. The clinician attempted to predict the vascular territory of the event before the patient had MRI of the brain on the same day using a 1.5-Tesla Siemens Symphony system with quantum gradients. The study protocol included an axial turbo gradient spin echo sequence (TR 4000 ms, TE 95 ms, 19 slices, slice thickness 6.0 mm, matrix 256×256, field of view 230×230) and a diffusion-weighted sequence (TR 260 ms, TE 184 ms, 20 slices, slice thickness 6.0 mm, matrix 128×128, field of view 230×230). The diffusion-weighted sequence was acquired with 3 different b values (b=0, 500, and 1000 s/mm²). A positive DWI scan was defined as high signal on the ADC map when comparing the affected area with the corresponding contralateral area. Furthermore, it was also assessed whether the lesions present on DWI were also present on the T2 image.

The scans were reviewed independently by a vascular neurologist and a neuroradiologist who determined the vascular territory of TIA or minor stroke between neurologists and DWI-MRI, the near “gold standard” of territory as defined by DWI according to the presence of specific symptoms.

Table. Agreement of Different Observers With Lesion Location as Defined by DWI According to the Presence of Specific Symptoms

<table>
<thead>
<tr>
<th>Symptoms</th>
<th>Observer 1: κ (SE)</th>
<th>Observer 2: κ (SE)</th>
<th>Observer 3: κ (SE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motor (N=90)</td>
<td>0.14 (0.14)</td>
<td>0.16 (0.15)</td>
<td>0.07 (0.12)</td>
</tr>
<tr>
<td>Visual (N=19)</td>
<td>0.77 (0.15)</td>
<td>0.67 (0.17)</td>
<td>0.63 (0.18)</td>
</tr>
<tr>
<td>Sensory (N=52)</td>
<td>0.76 (0.11)</td>
<td>0.51 (0.17)</td>
<td>0.73 (0.13)</td>
</tr>
<tr>
<td>Speech (N=63)</td>
<td>0.32 (0.17)</td>
<td>0.47 (0.17)</td>
<td>0.19 (0.14)</td>
</tr>
</tbody>
</table>

Results
One hundred thirty-three (28.0%) of 476 consecutive patients had a high signal lesion on DWI, of whom 115 (86.5%) had a minor stroke and 18 (13.5%) a TIA. Their mean age was 73.4 (SD 9.7) years and 70 (53%) were men. In 24 (18%) patients, the lesion was located in the posterior circulation.

Interobserver agreement on territory ranged from 0.46 to 0.60. The agreement with DWI was only moderate (observer 1: κ=0.54, 95% CI=0.36 to 0.72; observer 2: 0.48, 0.31 to 0.64; observer 3: 0.48, 0.28 to 0.67). The time interval between the ischemic event and scanning did not influence the accuracy of predicting the vascular territory. Only the presence of visual symptoms improved the accuracy of vascular territory diagnosis (range of κ: 0.63 to 0.77), but not the presence of motor, speech, or sensory symptoms (Table). Generally, the presence of isolated symptoms or signs at the time of the assessment (N=98) improved the accuracy only slightly (range of κ: 0.50 to 0.57). Excluding patients with a possible cardioembolic source (atrial fibrillation, N=18) did not improve the agreement with DWI (range of κ: 0.50 to 0.56).

The 3 posterior events that had been judged to have occurred in the anterior circulation by all 3 observers had all affected the pons and had caused an isolated hemiparesis (Figure 1); the 2 events that were thought by all observers to have occurred in the posterior territory but were anterior all involved the lateral thalamus and had caused hemiparesis plus dizziness and symptoms suggestive of ataxia (Figure 2).

Discussion
Previous studies have shown poor interobserver agreement between neurologists for the vascular territory of a TIA. To our knowledge, however, there have been no systematic studies that have investigated the agreement for the vascular territory of a recent TIA or minor stroke between neurologists and DWI-MRI, the near “gold standard” of lesion location. Our study confirms that the reliability of a clinical diagnosis of the vascular territory of a recent TIA or minor stroke is only moderate even when made by...
vascular neurologists, who used specific diagnostic criteria. In many cases, a confident diagnosis can only be reached after DWI. This holds true even for patients with minor stroke, like in the majority of the patients in our report. Our findings are broadly in agreement with the report by Kraaijeveld et al who reported an interobserver agreement between vascular neurologists for vascular territory of only $\kappa = 0.31$ in patients with a recent TIA.

The ability of patients to convey their symptoms and of doctors to interpret these histories varies. The presence of residual symptoms and signs, however, only marginally improved the accuracy of diagnosis. The main difficulty arises when lesions in different vascular territories produce identical symptoms, as can be the case for unilateral motor or sensory disturbance, slurred speech, unsteadiness, or swallowing difficulty. Clumsiness can be a symptom of minor weakness or ataxia. In general, isolated unilateral symptoms are taken as evidence for anterior ischemia; however, it is well established that lacunes in the pons, the cerebral peduncle, and the medullary pyramid produce virtually indistinguishable symptoms. Ataxia, on the other hand, is mostly felt to arise from posterior circulation ischemia; however, ischemia of the posterior limb of the internal capsule extending into the lateral thalamus can again produce very similar symptoms. Furthermore, there is individual variation in arterial anatomy and the collateral circulation. Lastly, functional systems in the brain are often supplied by both the anterior and posterior circulation (eg, the corticospinal tract). The accuracy was therefore greater for symptoms that are specific for a vascular territory such as isolated homonymous hemianopia, double vision, or dysphasia, but poor for motor and sensory symptoms, which are represented in both the anterior and posterior territory.

There were some possible shortcomings in our study; 2 of the observers had only read the clinical history of the event that was generated with a standardized questionnaire and had not actually seen the patients. However, the accuracy of the clinical diagnosis was no greater for the researcher who had seen the patients. Moreover, it is uncertain whether the reliability of the clinical diagnosis of the vascular territory would be even worse in the majority of patients with TIA in our series who did not have a lesion on DWI. Furthermore, it is possible that other neurologists would have a higher hit rate. However, all the observers in our study had a specific interest in vascular neurology and had several years of experience in seeing patients in TIA clinics. Lastly, although all DWI lesions were felt to be clinically relevant, we cannot rule out that perhaps some were incidental.

The reliability of a clinical diagnosis of the vascular territory of a recent TIA or minor stroke is only moderate. Sensitive brain imaging is vital to establish the true lesion location. This would be important, eg, in selecting patients for invasive procedures such as carotid endarterectomy or stenting, and is likely to result in a better risk/benefit ratio for these procedures. There is, however, currently no alternative to the clinical diagnosis in the substantial number of patients with TIA or minor stroke who do not have a relevant lesion on brain imaging. Further imaging-based studies are required to determine which clinical symptoms most reliably predict ischemia and the optimal clinical diagnostic criteria for classification of the vascular territory.

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**Figure 1.** Posterior circulation events thought to have occurred in the anterior territory. Patient 101 presented with weakness of his right face, arm, and leg. He also reported a preceding transient loss of vision in his left eye. He had a 70% stenosis of his left carotid artery. The DWI shows a fresh infarct in his left pons and fading high signal in his right occipital lobe, strongly suggesting preceding ischemia, both in the posterior vascular territory. Patient 282 similarly presented with weakness of his right side and had an infarct in the left pons.

**Figure 2.** Anterior circulation events thought to have occurred in the posterior territory. Patient 222 presented with weakness of his left hand and felt dizzy and unsteady. The DWI showed a high signal lesion in the posterior limb of the right internal capsule adjacent to the thalamus. Patient 311 presented with weakness on the left side involving his face, arm, and leg. He felt dizzy, was unsteady, and had a broad-based gait. The DWI showed a high signal lesion in the left internal capsule extending into the lateral thalamus.
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Disclosures
None.

References
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