Diffusion-Weighted Magnetic Resonance Imaging in Symptomatic Vertebrobasilar Atherosclerosis and Dissection

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Background: Acute multiple brain infarction (AMBI) pattern on diffusion-weighted imaging (DWI) is associated with arterial and cardiac sources of embolism. The DWI characteristics of patients with stroke due to vertebrobasilar arterial dissection and atherosclerotic disease have not been reported in detail.

Objective: To describe the DWI stroke patterns in patients with posterior circulation occlusive disease to determine mechanisms of ischemia.

Design: Retrospective analysis of infarct patterns in patients with symptomatic vertebrobasilar disease.

Setting: Large community-based teaching hospital.

Patients: Patients admitted with stroke due to vertebrobasilar disease were identified retrospectively. Patients were included if DWI was obtained within 7 days of symptom onset.

Main Outcome Measure: Infarct patterns were analyzed according to established templates of vascular territories.

Results: Eleven patients with vertebral dissection and 39 patients with atherothrombosis were identified. An AMBI pattern was present in 8 (72%) of 11 patients with arterial dissections and 25 (64%) of 39 patients with atherosclerotic disease (P=.48). Distal embolism to the terminal branches of the basilar artery occurred with equal frequency in both groups and was found in half of all cases. Isolated thalamic infarction did not occur. Pontine infarction was noted in 2 (18%) of 11 patients with dissections and 18 (46%) of 39 patients with atherosclerosis (P=.09). Cerebellar border zone involvement was found in 14 (36%) of 39 patients with atherosclerosis and 4 (37%) of 11 patients with dissections (P=.6).

Conclusions: Large arterial disease is frequently associated with AMBI in the posterior circulation. The incidence of AMBI was comparable to that reported in the anterior circulation. This DWI study supports the importance of embolism as the main mechanism of infarction in patients with vertebrobasilar occlusive disease. On the basis of our experience, large-vessel vertebrobasilar disease rarely causes isolated small-vessel thalamic infarction.

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DIFFUSION-WEIGHTED IMAGING (DWI) detects small ischemic lesions more reliably than conventional magnetic resonance imaging (MRI). An acute multiple brain infarction (AMBI) pattern on DWI is associated with arterial and cardiac sources of embolism and is believed to result from either repeated embolism or fragmentation of a single embolus, leading to separate areas of injury.1,2 The DWI characteristics of patients with strokes secondary to internal carotid artery and middle cerebral artery disease have been reported in detail.1,3 Few studies6-8 have examined DWI stroke patterns in patients with posterior circulation infarcts. These series6-8 included only a small number of patients with vertebrobasilar occlusive disease. We therefore undertook the present study to investigate the DWI characteristics of patients with acute ischemic strokes secondary to vertebrobasilar occlusive disease to characterize mechanisms of infarction.

METHODS

Patients admitted to a large community-based teaching hospital with acute posterior circulation stroke secondary to vertebrobasilar dissection or atherosclerotic disease exceeding 50%-diameter stenosis were identified by accessing our electronic clinical and angiographic databanks. Patients were included in...
A total of 63 patients with symptomatic vertebrobasilar disease were identified. Thirteen patients were excluded for the following reasons: DWI was performed more than 7 days from symptom onset (n = 6), contraindications to MRI were present (n = 2), no MRI was performed (n = 4), and DWI showed no lesions despite persistent stroke symptoms (n = 1). Of the remaining 50 patients, 39 were diagnosed as having atherosclerotic disease and 11 patients had arterial dissection. Mean age of the groups was 65 and 49 years, respectively. In the atherosclerotic group, 85% had a history of hypertension, 23% had diabetes, and 33% had dyslipidemia. Patients with dissection had a history of hypertension in 45%, diabetest in 27%, and dyslipidemia in 54% of cases. Cerebral angiography was performed in 82% of patients, with the remainder undergoing magnetic resonance angiography. All patients had an electrocardiogram on admission, and echocardiography (either transesophageal or transthoracic) was performed in 86%. Echocardiography showed medium-risk embolic sources in 7 patients (patent foramen ovale in 4, segmental wall motion abnormalities in 2, and mild global ventricular hypokinesis in 1). The DWI was obtained a mean of 58 hours (range, 5-144 hours) after symptom onset. Median time to imaging was 48 hours, and 14 patients underwent imaging within 24 hours.

Symptoms on presentation, vascular lesion site, and DWI patterns are illustrated in the Figure. The vascular lesion was proximal to the origin of the posterior inferior cerebellar artery in 16 (41%) of 39 patients with atherosclerosis and in all cases of dissection. In the atherosclerosis group, 15 (38%) had basilar artery or vertebrobasilar (unilateral or bilateral) junction stenosis or occlusion, 7 (18%) had bilateral vertebral disease, and 17 (44%) had unilateral vertebral stenosis or occlusion. Vessel occlusion was present in 7 (64%) of 11 patients with arterial dissection. In the atherosclerosis group, 17 patients (44%) had at least 1 vertebral occlusion and 7 (18%) had basilar occlusion. An AMBI was present in 8 (72%) of 11 arterial dissections and 25 (64%) of 39 patients with atherosclerotic disease and did not differ statistically between the 2 groups (P = .48). Distal embolism to the terminal branches of the basilar artery occurred with equal frequency and was found in 55% of dissections and 54% of patients with atherosclerosis. The thalamus was involved in 1 (9%) of 11 patients with dissection and 6 (15%) of 39 patients with atherosclerosis. Isolated thalamic infarction was not observed in any patient. The mean±SD number of lesions was 4.6±3.9 in patients with dissection and 3.1±2.1 in those with atherosclerosis (P = .08). Pontine infarction occurred in 2 (18%) of 11 patients with dissection and 18 (46%) of 39 patients with atherosclerosis (P = .09).

Cerebellar infarction was present in 9 (82%) of 11 patients with arterial dissection and 29 (74%) of 39 patients with atherosclerosis (P = .47). Cortical cerebellar involvement was observed in 8 (73%) of 11 arterial dissections and 11 (28%) of 39 patients with atherosclerotic infarction (P = .01). Cerebellar border zone involvement was found in 14 (36%) of 39 patients with atherosclerosis and 4 (37%) of 11 patients with dissection (P = .6). No isolated cerebellar border zone infarction occurred (ie, in every case of cerebellar border zone involvement, there was concomitant infarction in the brainstem, thalamus, occipital lobe, or cerebellar cortex).
We found that most patients with symptomatic vertebrobasilar large-vessel disease present with an AMBI pattern on DWI. No significant differences were apparent in the AMBI pattern between patients with dissection and atherosclerosis. Increased cortical cerebellar involvement was noted in dissection. Isolated thalamic infarcts were not seen in either group.

The AMBI pattern has been found in 29% of consecutive patients with stroke of all subtypes. Cardioembolism and large-vessel disease have been consistently associated with a higher incidence of AMBI. The AMBI pattern is seen in as many as 83% of patients with extra-
In strokes due to carotid dissection, 71% of patients had this pattern of infarction.14

Intra-arterial embolism is an important mechanism of stroke in posterior circulation occlusive disease.15,16 Previous studies of posterior circulation strokes have relied on conventional MRI and computed tomography, which are not as sensitive as DWI in detecting small ischemic lesions,9 and have enrolled patients with all stroke etiologies. In a series of 236 patients with posterior circulation infarction (37% with large vessel disease) evaluated with conventional MRI, 27 (11%) had AMBI, defined as contrast-enhancing lesions.17 In 22 patients with posterior circulation stroke and AMBI pattern on DWI, most (68%) had large vessel disease.8 In the New England Medical Center Posterior Circulation Stroke Registry, vertebrobasilar disease was the most frequent mechanism of infarction in patients with strokes in multiple arterial territories.18 A recent study described DWI characteristics of infratentorial strokes in 22 patients and found a higher lesion burden in patients with cardioembolic stroke than noted in the present study of large vessel stroke (8 vs 3.4).

Small deep cerebellar infarcts have been associated with large-vessel occlusive disease and may be due to hemo-dynamic mechanisms.10 With the increased sensitivity of DWI for small ischemic lesions, we demonstrate that border zone infarcts do not occur in isolation but are always associated with acute cortical cerebellar, brainstem, or supratentorial lesions. This suggests that embolism is the major mechanism of infarction in large-vessel vertebrobasilar occlusive disease.

We found no case of isolated thalamic small-vessel infarct in patients with proximal vertebrobasilar occlusive disease. In the anterior circulation, extracranial carotid disease may not be associated with lacunar infarction even though this issue remains unsettled.19,20 We believe that our data show that posterior circulation occlusive disease rarely results in isolated thalamic small-vessel infarction.

In summary, our study shows that large-artery disease is frequently associated with AMBI in the posterior circulation. The incidence of the AMBI pattern is comparable to that reported in the anterior circulation. We found no significant differences in the AMBI pattern between dissection and atherosclerotic stroke. Isolated small-vessel thalamic infarction is associated only rarely with large-vessel vertebrobasilar disease.

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