Early Magnetic Resonance Imaging Predicts Early Neurological Deterioration in Acute Middle Cerebral Artery Minor Stroke

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Background: Early neurological deterioration (END) is an important factor associated with worse clinical outcome in minor strokes. Early magnetic resonance imaging (MRI) findings can provide better sensitivity to delineate stroke pathophysiology and have diagnostic value associated with causative mechanisms. The aim of this study was to investigate the relationship between early MRI finding and the presence of END in minor stroke patients with lesions in the middle cerebral artery (MCA) territory. *Methods:* Consecutive MCA minor stroke patients who were admitted to our center within 24 hours of symptom onset were included in this study. All patients underwent MRI within 24 hours of admission. We analyzed baseline characteristics, infarction patterns, and treatment algorithms. The correlation between early MRI findings and END, defined as National Institutes of Health Stroke Scale score increasing more than 2 points during 72 hours after admission, was also determined. *Results:* Across 211 patients meeting entry criteria between January 2010 and December 2013, internal border-zone (IBZ) infarcts on early MRI scan were observed in 23 of 65 patients with END (35.4%) and in 18 of 146 patients without END (12.3%, $P < .001$). Patients with IBZ infarcts were found to have more hyperlipidemia, less perforating artery infarcts, more pial artery infarcts, more cortical border-zone infarcts and more ipsilateral large arterial stenosis. Logistic regression analysis revealed that IBZ infarct was independently associated with END after adjustment for other factors (odds ratio, 2.50; 95% confidence interval, 1.09-5.74; $P = .031$). *Conclusions:* Early MRI patterns of IBZ infarction are associated with END in minor stroke patients with acute

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infarcts of the MCA territory. **Key Words:** Stroke prognosis—neuroimaging of acute stroke—clinical outcome—outcome predictive factors—magnetic resonance imaging—infarct pattern—early neurological deterioration.

Introduction

Among acute stroke patients in China, approximately 30% have minor strokes that ultimately lead to disabling events.[1] Approximately 10% of minor stroke patients suffer a recurrent stroke within the first week that results in worse outcome.[2] For these patients, early neurological deterioration (END) is an important factor associated with worse clinical outcome. Although several studies[3-6] have attempted to identify factors associated with END in minor strokes, these studies did not refer to different vascular territories. To the best of our knowledge, there have been few studies to find the predictors of END in acute middle cerebral artery (MCA) minor stroke patients. The mechanism underlying neurological deterioration in these patients is still unknown.

Magnetic resonance imaging (MRI) with diffusion-weighted imaging (DWI) is the most sensitive modality after minor stroke.[7] The location and distribution of lesions on DWI have diagnostic value associated with the stroke mechanism.[8] Early MRI scanning of minor stroke patients could provide better sensitivity to identify stroke lesions and shows a different lesion topography than delayed MRI.[9,10] In previous studies,[3,11] it was demonstrated that early imaging findings might be helpful in predicting END in MCA stroke patient due to intracranial atherosclerosis. Therefore, we hypothesized that the findings on early MRI scanning could also provide predictive value in minor stroke patients with acute lesions of the MCA territory.

The aim of this study was to prospectively assess the relationship between early MRI findings and END, defined National Institutes of Health Stroke Scale (NIHSS) score increasing more than 2 points than baseline, in patients with acute MCA minor stroke.

Methods

Patient Selection

This study reviewed consecutive patients with a diagnosis of first-ever minor stroke localized to the MCA territory who were admitted to our hospital within 24 hours of symptom onset between January 2010 and December 2013. Patients were included in our study if they met the following criteria: (1) age older 18 years, (2) time from symptom onset to admission of 24 h or less, (3) an NIHSS score of 3 or lower on admission, (4) lesions distributed within MCA territory with DWI confirmation in 24 hours of admission. We excluded patients who met the following criteria: (1) age younger 18 years old, (2) infarcts in multiple vascular territories beyond the unilateral MCA territory, (3) underwent thrombolytic and endovascular therapy, (4) without MRI scan in 24 hours of admission or the MRI information was indistinguishable, and (5) had been discharged early within 3 days after admission. This study was approved by the Ethics Committee of Jinling Hospital, and all patients in our study gave informed consent for participation.

Clinical Assessment and Treatment

Demographic, clinical, and laboratory data were retrieved from prospective Nanjing Stroke Registry Program.[12] Hypertension, diabetes, hyperlipidemia, smoking, drinking, coronary artery disease (CAD), and arterial fibrillation (AF) were defined as stroke risk factors. Baseline characteristics were also collected from the patients in our study. The evaluation of neurological deficits was conducted using the NIHSS score at admission and continued at the following 72 hours 1-3 times a day. END is defined as an NIHSS score increased by 2 or more points during the first 72 hours compared with the initial NIHSS score. The evaluation of NIHSS score was conduct by certificated investigators who were blinded to the imaging information.

Imaging Analysis

According to our imaging protocol, patients were scheduled to undergo an MRI scanning during the first 24 hours after admission with a 3.0-T (MAGNETOM Avanto; Siemens, Munich, Germany) or 1.5-T (Signa; GE, Fairfield, CT) system largely depending on which one was available to achieve a quick evaluation. The imaging protocol included T1-weighted imaging, T2-weighted imaging, DWI, fluid-attenuated inversion recovery, susceptibility-weighted imaging, and 3-dimensional time-of-flight magnetic resonance angiography (MRA).

DWI lesions were classified as lesions of the pial artery (PI), perforating artery (PAI), internal border zone (IBZ), and cortical border zone (CBZ) as previously defined.[4] All patients in our study underwent either MRA or computed tomographic angiography to evaluate the status of cerebral vasculature. Arterial stenosis was defined as more than 50% narrowing of the lumen and focal signal loss. The images were analyzed by 2 experienced neuroradiologists who were blinded to the clinical characteristics. Discrepancies were resolved by consensus.