A Correlational Study on Cerebral Microbleeds and Carotid Atherosclerosis in Patients with Ischemic Stroke

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Purpose: This study aimed to investigate the correlation between cerebral microbleeds and carotid atherosclerosis in patients with ischemic stroke. *Subjects and Methods:* Patients with ischemic stroke treated in a hospital in China from 2016 to 2017 were enrolled in the study. Based on the results from susceptibility-weighted imaging, the patients were divided into cerebral microbleed and noncerebral microbleed groups. The degree of carotid atherosclerosis was assessed with carotid intima-media thickness (CIMB) and Crouse score of carotid plaque. The details of patients' demographic information, cerebrovascular disease-related risk factors, carotid atherosclerosis indices, cerebral microbleed distribution, and grading were recorded, compared, and analyzed. *Results:* Logistic regression analysis of the 198 patients showed that CIMB and Crouse score were significantly correlated with the occurrence of cerebral microbleeds. The CIMB thickening group ($P = .03$) and the plaque group ($P = .01$) were more susceptible to cerebral microbleeds. In the distribution of cerebral microbleed sites, Crouse scores were the highest in the mixed group and showed a statistically significant difference ($P < .01$). As the degree of carotid atherosclerosis increased, the average number of cerebral microbleeds also increased ($P < .01$). The receiver operating characteristic curve analysis of the carotid atherosclerosis indices showed a statistically significant difference. The CIMB value combined with the Crouse score was the best indicator ($P < .01$). *Conclusion:* In patients with ischemic stroke, cerebral microbleeds are closely related to carotid atherosclerosis. Active control of carotid atherosclerosis is important to prevent cerebral microbleeds in patients with ischemic stroke. **Key Words:** Cerebral microbleeds—ischemic stroke—carotid atherosclerosis—carotid intima-media thickness—Crouse score.

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Introduction

Ischemic stroke is the leading cause of disability in adults worldwide and the second most common cause of death.[1] Epidemiological evidence indicates that the incidence of first stroke is reduced by 20%-40% after controlling for stroke risk factors.[2] Cerebral microbleeds (CMBs) are a type of cerebrovascular disease that involve cerebral microvascular leakage or rupture, leading to perivascular deposition of hemosiderin and ferritin, thereby damaging the brain parenchyma. They are more commonly found in the cortex-subcortex and deep brain structures, such as the thalamus, brainstem, and basal ganglia.[3] In patients with noncerebrovascular disease, the incidence of CMBs is 6.4%;[4] whereas, the incidence of CMBs in lacunar infarcts is 27%.[5] One hypothesis on the mechanisms for the pathogenesis of CMBs is atherosclerosis (AS). Recent studies have shown that a correlation may exist between AS and CMBs.[6] The collateral compensation in neovascularization may be an important pathway for AS or arterial stenosis leading to CMBs. Patients with AS have a higher incidence of CMBs, and AS and CMBs have common risk factors such as hypertension, diabetes, and age.[7,8] As carotid lesions precede lesions in coronary and intracranial arteries, carotid arteries serve as windows for the occurrence of systemic AS. CMBs and carotid AS are closely related. However, the relationship between CMBs and carotid AS is rarely reported. In this study, we aimed to investigate the correlation between CMBs and carotid AS in patients with ischemic stroke.

Subjects and Methods

Study Subjects

Patients with ischemic stroke treated as inpatients or outpatients in the Department of Neurology of Tai'an City Central Hospital from September 2016 to November 2017 were included in this study. All patients received head susceptibility-weighted imaging (SWI). in grouping, a total of 198 patients were enrolled. Based on the results from head magnetic resonance imaging (MRI), patients were divided into the CMB and non-CMB groups. In subgroup analysis, according to the severity of CMBs, the patients were divided into grades 0-3 (grade 0: no CMBs; grade 1: 1-5 lesions; grade 2: 6-10 lesions; and grade 3: >10 lesions). In the CMB group, patients were further subdivided according to lesion site into the cortical and subcortical, deep brain (basal ganglia, thalamus), infratentorial (brainstem and cerebellum), and mixed groups. The study was approved by the ethics committee of Tai'an City Central Hospital, and all patients or their families signed the informed consent form. The diagnostic criteria complied with the Guidelines for the Prevention and Treatment of Ischemic Stroke in China (2010),[9] and the diagnosis was confirmed using head MRI. All patients underwent head MRI and carotid artery ultrasonography. Patients (range, 18-85 years) were enrolled, with no evident symptoms of nervous system impairments.

Head MRI Examination

The Magnetom Skyra 3.0T MRI system (Siemens, Erlangen, Germany) and head coils were used. All patients underwent SWI examination. SWI scan was performed (repetition time: 27 ms, echo time: 20 ms, Field Of View: 220 mm, and slice thickness: 1.5 mm). All images were read by 2 experienced radiologists, and relevant imaging data were recorded. In the CMB diagnosis of the head MR images, CMBs are circular areas of signal loss that are generally 2-5 mm in diameter but can measure up to less than 10 mm. In the head SWI, CMBs are circular or quasicircular hypointense loci with no peripheral edema. The lesion needs to be distinguished from other types of hypointense signals, such as calcium and iron deposits, flow voids, diffuse axonal injury, and cavernous hemangioma.

Assessment of Carotid AS

A color Doppler ultrasound system (Aplio XG SSA-790A; Toshiba Medical Systems Corporation, Tokyo, Japan) was used to assess carotid AS, including carotid intima-media thickness (CIMT) and plaque Crouse score. The CIMT value and plaque Crouse score were used to evaluate the degree of carotid AS. The measurement method used was to lay the subjects in a supine position with the neck exposed. The probe was placed on the neck, and transverse scanning was performed from the root of the neck to the head. The intima-media thickness was measured on the longitudinal axis of the probe. The posterior walls of the bilateral common carotid artery (1 cm before the bifurcation) and the internal carotid artery (1 cm after the bifurcation), and the bifurcation of the carotid artery were examined. The CIMT is the thickness from the tunica intima to the outer surface of the tunica media of the blood vessel. The focal measuring sites were magnified, and the ultrasound beam was adjusted to be perpendicular to the wall. The average value of the 6 sites was the average CIMT. The judgment criteria is that in longitudinal sections, CIMT of 1.0 mm or less was considered to be normal and 1.0-1.2 mm to be thickened; whereas, 1.2 mm or greater indicates the formation of atherosclerotic plaques. Crouse scoring was used to assess plaques. By scanning the long and short axes of the carotid artery, all existing carotid plaques were found and the maximum thickness (mm) of each plaque was independently measured. To determine Crouse score,[10] the sum of the bilateral maximum CIMT values was calculated. If the CIMT was less than 1.2 mm, the Crouse score was 0. Carotid ultrasonography data were recorded by physicians who were unaware of the clinical data.