Low Body Mass Index is a Poor Prognosis Factor in Cardioembolic Stroke Patients with NonValvular Atrial Fibrillation

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Background: The relationship between body mass index (BMI) and the severity of cardioembolic stroke (CES) remains poorly understood. *Method:* A total of 419 consecutive CES patients with nonvalvular atrial fibrillation (NVAF), and with a modified Rankin Scale (mRS) score of 0 or 1 before onset admitted within 48 hours after onset to the Hirosaki Stroke and Rehabilitation Center were studied. The patients were divided into three groups, low BMI (L-BMI; $n = 36$, BMI < 18.5 kg/m^2), normal BMI (N-BMI; $n = 284$, $18.5 \leq$ BMI < 25.0), and high BMI (H-BMI; $n = 99$, BMI ≥ 25.0). We compared stroke severity and functional outcome among the three groups. *Results:* Stroke severity on admission, assessed by the National Institutes of Health Stroke Scale (NIHSS) showed that patients with L-BMI had the highest NIHSS score (median, 16 [11-25]), followed by N-BMI and H-BMI (11 [5-19] and 9 [3-19], $P = .002$). Functional outcome at discharge, assessed by mRS, was most severe in L-BMI patients (5 [3-5]), followed by N-BMI and H-BMI (3 [1-4] and 2 [1-4], $P = .001$). Multivariate analyses revealed that L-BMI was a significant determinant of severe stroke (NIHSS scores ≥ 8) at admission (odds ratio [OR] to N-BMI = 2.79, 95% confidence interval [CI], 1.17-7.78, $P = .02$) and poor functional outcome (mRS scores ≥ 3) at discharge (OR = 2.53, 95% CI, 1.12-6.31, $P = .02$). However, H-BMI did not affect stroke severity at admission or functional outcome at discharge. *Conclusion:* Low BMI is a risk factor for severe stroke on admission and unfavorable functional outcome at discharge in Japanese CES patients with NVAF.

Key Words: Low body mass index—nonvalvular atrial fibrillation—cardioembolic stroke—stroke severity—functional outcome

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Introduction

There have been numerous studies on the relationship between incidence of stroke and body mass index (BMI). In the United States and Europe, a strong relationship between the increase in BMI and the risk of stroke, especially ischemic stroke, has been observed.[1–6] In the Asia-Pacific Cohort Studies Collaboration, the risk of ischemic stroke was shown to increase with BMI; for hemorrhagic stroke, however, there was no clear relationship between BMI and stroke risk.[7] Among East Asian population, a high BMI is considered a risk factor for ischemic and hemorrhagic stroke.[8] In Japan, an increase in obesity was associated with incidence of cerebral infarction and a risk of developing cerebral hemorrhage in both males and females[9]; in another report, a high BMI and weight gain of less than or equal to 10% over a period of 5 years were associated with an increased risk of stroke in women, but this association was weak in men.[10] In a recent report from Japan, low BMI was observed to be a risk factor for all-stroke and cerebral infarction in men, while a high BMI was observed to be a risk factor for all-stroke in women.[11]

There have also been some studies on the relationship between BMI at the time of stroke onset and the mortality rate after onset.[12–15] These studies suggest that it is still unclear whether a high BMI is associated with high mortality or oppositely low mortality. In Chinese patients with acute ischemic stroke, obesity or weight gain was not found to be associated with decreased mortality or better functional recovery, but being underweight predicted unfavorable outcomes.[16] Furthermore, in Japanese patients with acute ischemic stroke, the patients with a lower BMI had a significantly higher rate of poor outcomes compared with those with a normal BMI.[17]

Currently, the Japanese are a super-aging society, and cardioembolic stroke (CES) due to atrial fibrillation (AF) is increasing as the population ages. The Japanese population is less obese than the Westerners, and many elderly Japanese are underweight. These underweight AF patients show a higher incidence of stroke and systemic embolism compared with overweight patients or those with normal body-weight.[18,19] However, the relationship between BMI and prognosis in CES patients with nonvalvular atrial fibrillation (NVAF) remains unknown. Therefore, the purpose of this study was to evaluate the stroke severity and prognosis of acute CES patients with NVAF on the basis of BMI.

Methods

Study Patients

Hirosaki Stroke and Rehabilitation Center (HSRC) has both a stroke care unit for acute therapy and a stroke rehabilitation unit for rehabilitation therapy. Thus, all patients with acute ischemic stroke admitted to HSRC receive consistent therapy in the acute phase and subsequently in the chronic phase during hospitalization.

Over a 5-year period from April 2011 to March 2016, a total of 1022 consecutive CES patients were admitted to the HSRC for acute therapy and for further rehabilitation within 60 days of the CES onset. Of these, 419 CES patients with NVAF admitted to the HSRC within 48 hours after onset and with a modified Rankin Scale (mRS) score of 0 or 1, without any limitation of physical activities before onset, were included in the current study (Fig. 1).

The heights and weights of these 419 patients were determined at hospitalization, and BMI was calculated (kilograms per square meter). They were divided into three groups: low BMI (L-BMI; $n = 36$, BMI < 18.5 kg/m^2), normal BMI (N-BMI; $n = 284$, $18.5 \leq$ BMI < 25.0), and high BMI (H-BMI; $n = 99$, BMI ≥ 25.0). Clinical characteristics, stroke severity on admission, and functional outcome at discharge were compared among these three groups.

This study was approved by the ethics committees of the HSRC and the subjects registered in the Hirosaki Stroke Registry (UMIN Clinical Trials Registry: UMIN000016880) were studied.

Diagnosis, Stroke Severity, and Outcome

All patients underwent a computed tomography scan of the brain on admission. When intracerebral hemorrhage was not detected, we further performed magnetic resonance (MR) imaging, including transversal diffusion weighted imaging, T2-weighted imaging, fluid-attenuated inversion recovery, and magnetic resonance angiography (Signa Excite HD 1.5T; GE Medical System, Waukesha, WI). Carotid ultrasonography, chest X-ray, 12-lead electrocardiogram (ECG), 24-hours Holter ECG, and

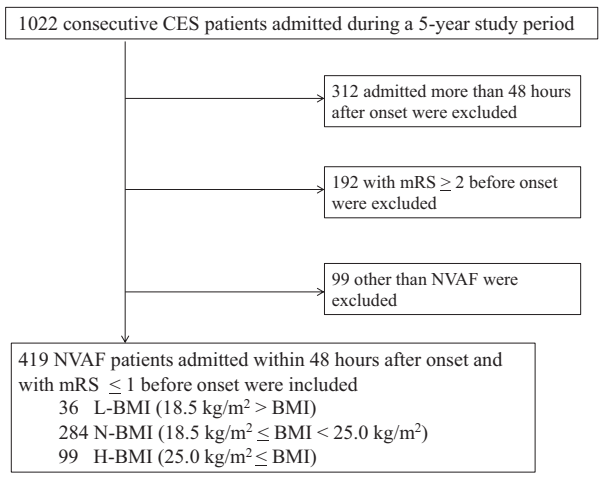

Figure 1. *Flowchart of the patient selection. CES indicates cardioembolic stroke, mRS; modified Rankin Scale, NVAF; nonvalvular atrial fibrillation, L-BMI; low body mass index, N-BMI; normal body mass index, H-BMI; high body mass index.*