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Impact of Body Mass Index on the Location of Spontaneous Intracerebral Hemorrhage

Hidetoshi Matsukawa[1], Masaki Shinoda[1], Motoharu Fujii[1], Osamu Takahashi[2], Daisuke Yamamoto[1], Atsushi Murakata[1], Ryoichi Ishikawa[1]

Key words
- Body mass index
- Intracerebral hemorrhage
- Lobar hemorrhage
- Location
- Multivariate logistic regression analysis
- Pontine hemorrhage

Abbreviations and Acronyms
BMI: Body mass index
CAA: Cerebral amyloid angiopathy
ICH: Intracerebral hemorrhage
LH: Lobar hemorrhage
PH: Pontine hemorrhage

From the [1]Department of Neurosurgery, and the [2]Division of General Internal Medicine, Department of Medicine, St. Luke's International Hospital, Tokyo, Japan

To whom correspondence should be addressed: Hidetoshi Matsukawa, M.D. [E-mail: mahide@luke.or.jp]

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BACKGROUND: **Although there have been some reports regarding body mass index (BMI) and subtypes of stroke, there have been few concerning the relationship between BMI and location of spontaneous intracerebral hemorrhage (ICH). Determining the location of spontaneous ICH is important because outcome is thought to be affected by its location. The aim of this study was to determine whether location of spontaneous ICH varied according to BMI level.**

METHODS: **In this retrospective study, 463 patients with spontaneous ICH were divided into 3 groups according to BMI (kg/m^2): <18.5 (underweight), 18.5 to 24.0 (normal weight), 24.0 to 29 (overweight), and >29.0 (obesity). We compared the clinical characteristics among patients with putaminal, thalamic, lobar, pontine, or cerebellar hemorrhage on univariate and multinominal logistic regression analysis.**

RESULTS: **Among the 5 locations, BMI level was lowest in patients with lobar hemorrhage and highest in those with pontine hemorrhage. Compared to patients with nonlobar hemorrhage, patients with lobar hemorrhage showed a higher proportion of individuals who were underweight, female, and age >70 years and a lower proportion who were hypertensive. Compared with patients with nonpontine hemorrhage, those with pontine hemorrhage showed a higher proportion of individuals who were obese.**

CONCLUSIONS: **Our findings indicate that BMI can affect the location of spontaneous ICH.**

INTRODUCTION

Intracerebral hemorrhage (ICH) seems to be more common in Japan than in Western countries, with published rates in the Japanese population of 43 to 47 per 100,000 (13, 29). Among the several studies to investigate the relationship between body mass index (BMI) and incidence of spontaneous ICH, some have shown that elevated BMI is related to ICH (1, 26), whereas others have shown that lower BMI is associated with ICH (4), or that BMI level does not affect incidence of ICH (27, 28). Thus, any association between BMI and ICH remains unclear. In some previous studies, the location of ICH was attributed to hypertension (5, 16, 34), apolipoprotein E genotype (19, 32, 34), race (7), and antithrombotic use (11, 17). Because location is thought to affect the prognosis of ICH (6, 13), it is important to obtain information about factors affecting its location. As stated earlier, although there are reports of an association between BMI and ICH, the relationship between BMI and the location of spontaneous ICH has not been well investigated. The aim of this study was, therefore, to examine the relationship between BMI and the location of spontaneous ICH.

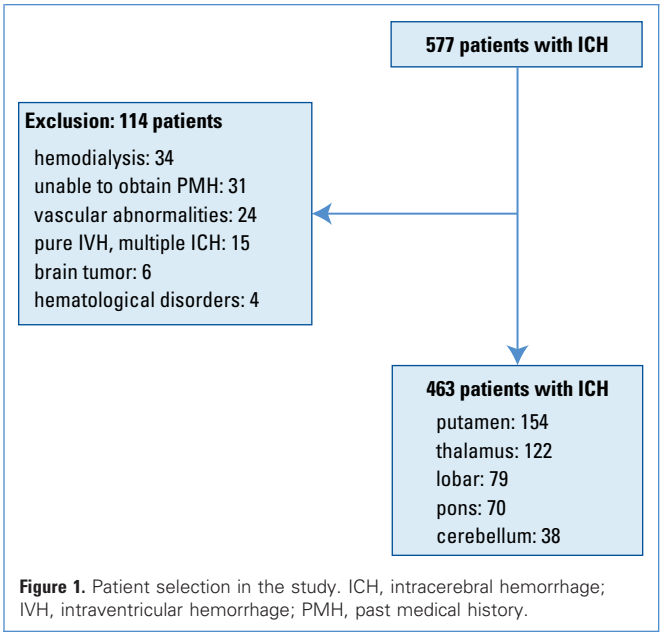

Figure 1. Patient selection in the study. ICH, intracerebral hemorrhage; IVH, intraventricular hemorrhage; PMH, past medical history.

MATERIALS AND METHODS

We retrospectively reviewed a total of 577 consecutive patients with first-ever ICH admitted to the Department of Neurosurgery, St. Luke's International Hospital, Tokyo, between April 2004 and April 2010. Patient selection in this study is shown in **Figure 1**. Patients with ICH caused by brain tumor, hematological disorders (malignant lymphoma, hemophilia, and myelodysplastic syndrome), hemodialysis, or vascular abnormalities (arteriovenous malformation, aneurysm, and cavernous angioma), were excluded, as were those whose past medical history could not be obtained, who were diagnosed as having pure intraventricular hemorrhage in which the origin could not be determined, or who had multiple ICHs. After exclusions, data from 463 patients with spontaneous ICH were analyzed in this study.

Height and weight were measured at the bedside by trained staff on admission using a measure and a digital weight scale, respectively, and BMI was calculated as standard. BMI (kg/m^2) was defined on the basis of the World Health Organization BMI categories for the Japanese population (3) as follows: <18.5 (underweight), 18.5 to 24.0 (normal weight), 24.0 to 29.0 (overweight), and >29.0 (obesity).

ICH was diagnosed based on brain computed tomography, and the location of ICH was classified into 5 areas: putamen, thalamus, lobe, pons, and cerebellum. The recorded variables included: blood pressure (systolic, diastolic, and mean), Glasgow Coma Scale score, and laboratory data (levels of serum albumin, hemoglobin A1c, low-density lipoprotein cholesterol, high-density lipoprotein cholesterol, and triglycerides). Information regarding past medical history (hypertension, diabetes mellitus, hypercholesterolemia, ischemic stroke, and ischemic heart disease), antithrombotics use, smoking status, and alcohol consumption was obtained from the patients, their family, or their family physicians. Hypertension was defined as taking antihypertensive agents, a systolic blood pressure >140 mm Hg, or a diastolic blood pressure >90 mm Hg. Diabetes mellitus was defined as taking antidiabetes agents, receiving insulin injection, a fasting plasma glucose level >126 mol/L, a random plasma glucose level >200 mol/L, or a hemoglobin A1c level >6.5%. Hypercholesterolemia was defined as taking antihyperlipidemic agents or having a total cholesterol level >220 mol/L. Antithrombotics included agents such as warfarin, aspirin, ticlopidine, cilostazol, and clopidogrel. Smoking status was dichotomized into current smoker or not. Alcohol consumption was also dichotomized into more or less than 5 times per week.

Statistical Analysis

Statistical analysis was performed using JMP 8.0 (SAS Inc. Cary, North Carolina, USA). Normality of the data was evaluated using the Shapiro-Wilk test. Statistical tests were 2-sided. Variables are expressed as mean (± SD), median (interquartile range, 25th to 75th percentile), or number of patients (%), as appropriate. Among the 5 locations, the BMI level of patients with lobar hemorrhage (LH) was significantly lower and the BMI level of those with pontine hemorrhage (PH) was significantly higher than the BMI level of those with ICH at other locations as determined by the Turkey-Kramer test (**Table 1**). In further analysis, we therefore compared the clinical characteristics between patients with LH and those with non-LH, and between patients with PH and those with non-PH. All continuous variables were nonnormally distributed and then compared using the Mann-Whitney U test. Pearson χ^2 or Fisher exact

Table 1. Comparison of Patients with Spontaneous Intracerebral Hemorrhage by Body Mass Index Level

Location	BMI (IQR)	*P* Value			
		Putamen Control	Thalamus Control	Lobar Control	Pons Control
Putamen (n = 154)	23.5 (20.7–23.5)	1			
Thalamus (n = 122)	23.1 (20.9–25.8)	.9892	1		
Lobe (n = 79)	20.6 (17.9–23.1)	<.0001	<.0001	1	
Pons (n = 70)	25.4 (23.3–27.7)	<.0001	<.0001	<.0001	1
Cerebellum (n = 38)	23.1 (20.6–26.2)	.9675	.9978	.0062	.0008

P values determined by Tukey-Kramer test.
BMI, body mass index; IQR, interquartile range.