Higher Left Ventricle Mass Indices Predict Favorable Outcome in Stroke Patients with Thrombolysis

Fei Wu, MD,* Wenjie Cao, MD,* Yifeng Ling, MD,* Lumeng Yang, MD,* Xin Cheng, MD, PhD,* and Qiang Dong, MD, PhD*†

Background: We sought to assess the association of left ventricle mass (LVM) indices with the functional outcome of acute ischemic stroke (AIS) patients after intravenous tissue plasminogen activator (IV-tPA). *Methods:* Consecutive AIS patients with IV-tPA were recruited. LVM indices including LVM/weight, LVM/surface, and LVM/height$^{2.7}$ on echocardiogram during hospitalization were retrospectively reviewed. Outcome was 90-day modified Rankin scale (mRS) scores. Multivariate logistic regression was performed to analyze the association of LVM indices with outcome. *Results:* Between August 2010 and May 2014, 55 AIS patients (age range from 27 to 78 years, 69.1% men) with echocardiogram after thrombolysis were recruited. Lower baseline National Institutes of Health Stroke Scale (NIHSS; $P = .009$) and higher LVM indices (LVM/weight [$P = .012$], LVM/surface [$P = .039$], and LVM/height$^{2.7}$ [$P = .045$]) were significantly associated with 90-day favorable outcome (mRS, 0-2). In multivariate logistic regression analysis, LVM/weight independently predicted good outcome with an odds ratio of 3.89 (95% confidence interval, 1.05-14.42, $P = .042$) after adjustment for baseline NIHSS, onset-to-treatment time, hypertension, hemorrhagic transformation, and systolic left ventricle inner diameters. *Conclusions:* Higher LVM indices on echocardiogram are significantly associated with favorable outcome in stroke patients with IV-tPA, among which LVM/weight seems to be the most effective. **Key Words:** Echocardiogram—thrombolysis—left ventricle mass—stroke outcome.

Ischemic stroke is one of the leading causes of death and the first cause of disability in industrialized countries.[1] Systemic thrombolysis with intravenous tissue plasminogen activator (IV-tPA) is the only Food and Drug Administration–approved reperfusion therapy within 4.5 hours from symptom onset.[2] Recently, researches are trying to reveal the association between cardiac function and ischemic stroke.[3,4]

Left ventricular hypertrophy (LVH) is considered to be a consequence of chronically increased left ventricular afterload. Echocardiographically estimated left ventricle mass (LVM) indices including LVM/surface, LVM/height, and LVM/height$^{2.7}$ are effective for the detection of LVH, which could provide important prognostic information.[5,6] Obesity causes intrinsic changes in the heart including an increase in LVM.[7] Several researches in rats have explored the significance of LVM/weight.[8] However, the predictive role of LVM indices in acute ischemic stroke (AIS) patients with IV-tPA has not been established yet.

We sought to assess the association of LVM indices with the functional outcome of AIS patients after IV-tPA. We hypothesized LVM indices, especially LVM/weight,

From the *Department of Neurology, Huashan Hospital, Fudan University, Shanghai; and †State Key Laboratory of Medical Neurobiology, Fudan University, Shanghai, China.

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F.W. and W.C. contributed equally to this study.

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Address correspondence to Qiang Dong, MD, PhD and Wenjie Cao, MD, Department of Neurology, Huashan Hospital, No.12 Wulumuqi Zhong Rd., Shanghai 200040, China. E-mail: wenjiecao@fudan.edu.cn; dongqiang2222@gmail.com.

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might be of useful utilities to predict the outcome in AIS patients.

Methods

Patients

We identified AIS patients presenting to our institution between August 2010 and May 2014 within 4.5 hours of stroke symptom onset who received IV-tPA from our prospectively recorded stroke database. Those with routine echocardiogram during admission were recruited. Baseline National Institutes of Health Stroke Scale (NIHSS), onset-to-treatment time (OTT), height, weight, and risk factors were obtained from the database. The study was performed with the informed consent of subjects or next of kin and with ethical approval from the institutional review boards of Huashan Hospital.

Echocardiogram

Echocardiograms were performed in the left lateral decubitus position using standard imaging planes according to the American Society of Echocardiography recommendations[9] during hospitalization after IV-tPA. Left ventricular end-diastolic diameter, ventricular septal thickness, and posterior wall thickness in end-diastole were measured in end-diastole. The LVM was calculated using the following formula[10]: LVM (g) = .806 × (1.046 × [{ventricular septal thickness + left ventricular end-diastolic diameter + posterior wall thickness}^{3} − {left ventricular end-diastolic diameter}^{3}]) + .6 g. LVM indices were presented with LVM/weight (LVM divided by weight), LVM/height (LVM divided by height), LVM/height$^{2.7}$ (LVM divided by height$^{2.7}$), and LVM/surface (LVM divided by body surface area).

Computed Tomography (CT)/Magnetic Resonance Imaging (MRI)

CT scans of the brain were taken and assessed before IV-tPA and 24 hours after IV-tPA. Other CT scans were taken if necessary. Several patients undertook MRI 24 hours after thrombolysis. Hemorrhagic transformation (HT) was defined according to the European Cooperative Acute Stroke Study on CT as an area of increased attenuation within an area of low attenuation in a typical vascular distribution.[11] On MRI, HT was identified by the presence of blood-product signal characteristics on T1, T2, and gradient-echo sequences.[12]

Outcome Measures

The primary outcome was disability at day 90 (3-month visit), as assessed by means of the modified Rankin scale (mRS) scores, dichotomized as favorable outcome (score of 0-2) or unfavorable outcome (score of 3-6). The secondary outcome was early neurologic improvement (ENI) defined with NIHSS score 24 hours post-treatment improvement by 40% from baseline.

Statistical Analysis

Statistical analyses were performed using SPSS, version 21 (SPSS Inc., Chicago, IL). P value less than .05 was considered to indicate statistical significance. Differences in patients' characteristics between outcomes were tested by chi-square or Fisher exact test for categorical and Mann–Whiney for continuous values. Spearman's nonparametric rank correlation was performed to assess the correlation between different LVM indices. Multivariate logistic regression (including variables with $P < .10$ and $P < .15$) was used to assess the association of variables with favorable outcome. Receiver operating characteristic analysis was performed to determine the optimal threshold of LVM/weight in predicting 90-day mRS (0-2).

Results

From August 2010 to May 2014, one hundred sixty-eight patients within 4.5 hours of stroke symptom onset received IV-tPA in our institution. Of those, 55 patients had echocardiograms after admission. There was no significant difference in baseline characteristics and 90-day functional outcome in these patients compared with the entire population. And 67.3% (37 of 55) of patients achieved favorable functional outcome with 90-day mRS 0-2. Hemorrhagic transformation occurred in 9.1% (5 of 55) of the patients and was associated with poor functional outcome (P = .035). Three patients died at 90-day follow-up.

As for the different LVM indices, LVM/weight showed good correlation with LVM/surface (r = .95, $P < .01$) and LVM/height$^{2.7}$(r = .84, $P < .01$).

Patient's characteristics in total and stratified by outcomes are listed in Table 1 and Table 2. Lower baseline NIHSS (P = .009), higher LVM/weight (P = .012), higher LVM/surface (P = .039), and higher LVM/height$^{2.7}$ (P = .045) were significantly associated with good functional outcome (90-day mRS 0-2).

In multivariate logistic regression analysis of factors with P value less than .1, LVM/weight, LVM/surface, and LVM/height$^{2.7}$ were able to predict 90-day functional outcome with odds ratio (OR) 5.02 (95% confidence interval [CI], 1.39-15.16), 1.04 (95% CI, 1.00-1.07), and 1.06 (95% CI, 1.00-1.13), respectively, after adjustment for baseline NIHSS and hemorrhagic transformation. Moreover, in multivariate logistic regression analysis of factors with P value less than .15, the association remained significant between LVM/weight and outcome (OR, 3.89; 95% CI, 1.05-14.42; P = .042) after adjustment for baseline NIHSS, OTT, hypertension, hemorrhagic transformation, and systolic left ventricle inner diameters (Table 3).