Pulse Blood Pressure Correlates with Late Outcome in Acute Ischemic Stroke without Significant Culprit Artery Stenosis

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Background: This study was conducted to test the hypothesis that elevated blood pressure at the early stage is associated with unfavorable outcome in acute ischemic stroke patients with stenosis of less than 50% of the culprit artery. *Methods:* Patients with acute ischemic stroke onset within 48 hours and stenosis of less than 50% of the culprit artery from a prospective stroke registry were analyzed. A modified Rankin Scale score of 1 or lower at 3 months was defined as a favorable late outcome. Univariate and multivariate logistic regression analyses were used to analyze the association between hemodynamic parameters and outcome. *Results:* One hundred thirty-six patients fulfilled the selection criteria. Patients with favorable outcome had lower pulse pressure at emergency department (ED) triage, lower systolic blood pressure (SBP) at 24 hours, lower pulse pressure at 24 hours, and lower heart rate (HR) at 24 hours. The univariate logistic regression analysis showed that history of stroke, elevated SBP at 24 hours, elevated HR at 24 hours, elevated pulse pressure at 24 hours, and higher National Institutes of Health Stroke Scale score at ED triage were associated with a less favorable late outcome. Two separate models of multivariate logistic regression analyses showed that pulse pressure at ED triage and pulse pressure at 24 hours, respectively, were significantly associated with less favorable outcome. *Conclusions:* Elevated pulse pressure at the early stage is independently associated with unfavorable late outcome in acute ischemic stroke patients with culprit artery stenosis less than 50%. **Key Words:** Acute ischemic stroke—blood pressure—cerebral arteries—outcome.

Introduction

Blood pressure (BP) is an important determinant of cerebral perfusion in acute ischemic stroke (AIS). However, the association between BP at the acute stage and outcomes of AIS remains controversial, and the results are contradictory among prior studies.[1-6] Some studies demonstrate that high poststroke BP was associated with increased risk of early stroke recurrence, death or dependency, and elevated risks of neurological deterioration.[1-3] In a systematic review,[2] high initial BP conferred a 1.5- to 5.0-fold increased risk of death or dependency and clinical deterioration in both intracerebral hemorrhage and ischemic stroke. On the contrary, some studies demonstrate that patients with high poststroke BP had milder stroke, a trend of complete neurological recovery,[4] and a more favorable outcome.[4-6] These discrepancies might be caused by uneven distribution of stroke subtypes and possibly the presence of culprit artery stenosis. Low poststroke BP had been demonstrated as an independent risk factor for mortality in patients with stenosis of 50% or higher or occlusion of the carotid ipsilateral to

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the index stroke.[7] Conversely, the relationship between BP at the early stage and late outcome in AIS patients without significant culprit artery stenosis has not been reported. Markedly increasing poststroke BP at the acute stage had been reported to be associated with blood–brain barrier disruption, facilitate edema formation,[8,9] and lead to hemorrhagic transformation.[10] The adverse effects from high poststroke BP might be even more prominent in AIS patients without significant culprit artery stenosis.

The present study was conducted to test the hypothesis that elevated BP at the early stage is associated with unfavorable outcome in AIS patients with stenosis of less than 50% of the culprit artery.

Patients and Methods

Patients

From October 15, 2012, to October 14, 2013, 463 patients who were admitted for AIS to Taichung Veterans General Hospital, a tertiary care academic medical center in Taiwan, were prospectively registered in Taiwan's Multicenter Stroke Registry Study, which was approved by the Institutional Review Board of Taichung Veterans General Hospital (CF12230). Informed written consent was obtained from all patients. We treated all patients according to guidelines described elsewhere.[11] Among the 463 patients, 288 patients who visited the emergency department (ED) within 48 hours after stroke onset were initially reviewed. Exclusion criteria were (1) occlusion or significant stenosis of 50% or higher of the culprit cerebral artery (87 patients), (2) use of BP-lowering drugs in the first 24 hours after the ED visit due to markedly elevated BP (7 patients), (3) use of thrombolytic therapy for the index stroke (19 patients), (4) active cancers (16 patients), (5) a history of other neurological psychiatric diseases (7 patients), (6) concurrent systemic infection in the first week after admission (11 patients), (7) discharge against medical advice (2 patients), and (8) a follow-up period of less than 3 months (3 patients).

Assessments of Culprit Artery Stenosis

All registered subjects received duplex sonography of cervical arteries and transcranial color-coded sonography of intracranial cerebral arteries. Brain computed tomography angiography or brain magnetic resonance angiography was performed to assess the cerebral arteries if absence of temporal bone acoustic windows was demonstrated on transcranial color-coded sonography. The degree of stenosis of cerebral arteries was defined by validated criteria accordingly.[12-15] Significant stenosis of the culprit artery is defined as occlusion or a stenosis of 50% or higher of a culprit intracranial or extracranial artery responsible for the index stroke.

Risk Factors, Clinical Characteristics, and Outcomes

Demographic characteristics, risk factors, and ancillary tests at admission were recorded: current smoking within a month, hypertension, diabetes mellitus, hypercholesterolemia, coronary heart disease, congestive heart failure, atrial fibrillation, old stroke, current use of BP-lowering drugs, and body mass index. Stroke severity was scored using the National Institutes of Health Stroke Scale (NIHSS) at the ED. All patients were classified into different subtypes based on the criteria from the Trial of Org 10172 in Acute Stroke Treatment study.[16] Functional assessments were measured using modified Rankin Scale (mRS) on the third month. Favorable outcome was defined as an mRS score of 1 or lower at 3 months.

Measurements of Hemodynamic Parameters

All BPs and heart rates (HRs) were measured in the supine position at the nonhemiplegic arm of all patients at ED triage and at 24 hours after the ED visit. Hemodynamic parameters measured at ED triage included systolic blood pressure (SBP), diastolic blood pressure (DBP), mean blood pressure BP (MBP), pulse blood pressure (PBP), and HR. The hemodynamic parameters were also measured at 24 hours after ED visit.

Statistical Analysis

Patients who fulfilled the selection criteria were divided into 2 groups according to outcomes at 3 months. Continuous variables are expressed as mean ± standard deviation. Categorical variables are expressed as percentages. The Mann–Whitney test or χ^2 test was used to compare corresponding variables between groups with and without favorable outcome. Variables with a P value less than .10 in the Mann–Whitney test or the χ^2 test or pivotal risk factors were subsequently analyzed using univariate and multivariate logistic regressions by forward stepwise method to assess the association with late outcome at 3 months. Due to the concern that correlations of hemodynamic parameters between ED triage and 24 hours may interfere with the analysis, we adopted 2 models of multivariate logistic regression which analyzed hemodynamic parameters of ED triage and 24 hours separately. P values less than .05 were considered significant. We used the SPSS 20.0 program (SPSS Inc., Armonk, NY: IBM Corp.) for statistical analyses.

Results

Among the 288 patients who visited the ED in 48 hours after stroke onset, 136 fulfilled the selection criteria. Seventy-three patients (53.7%) had favorable outcome at 3 months. Clinical profiles and laboratory findings of each outcome group are summarized in Table 1. Patients with favorable outcome were less likely to have diabetes (24.7%