Accuracy of National Institutes of Health Stroke Scale Score in Predicting the Site of Arterial Occlusion in Acute Stroke: A Transcranial Doppler Study

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Background: In acute stroke, it is crucial to assess for intracranial large-vessel occlusion and site of occlusion. The National Institutes of Health Stroke Scale score (NIHSSS) is the frequently used clinical tool to predict the site of arterial occlusion. In this study we aimed to determine the following: (1) if there is a correlation between the site of occlusion and the NIHSSS at presentation (bNIHSSS); and (2) if there is a bNIHSSS cutoff which can distinguish proximal occlusions (PO) from distal occlusions (DO). *Methods:* Up to 313 patients from CLOTBUST data bank with demonstrable intracranial arterial occlusion and having received intravenous recombinant tissue plasminogen activator (rt-PA) were included. Occlusions were classified as PO (terminal internal carotid artery, M1 segment of middle cerebral artery [M1 MCA], and basilar artery) or DO (M2 MCA, anterior cerebral artery, posterior cerebral artery, and vertebral artery). *Results:* By univariate analysis, bNIHSSS, thrombolysis in brain ischemia (TIBI) flow grade before rt-PA, degree of recanalization after rt-PA, and modified Rankin Scale score at 3 months were significantly different between various sites of occlusion. By univariate analysis, a higher bNIHSSS, lower TIBI flow grade, and lower ASPECTS (Alberta Stroke Program Early CT Score) differentiated PO from DO. Lower TIBI flow grade and higher bNIHSSS differentiated PO from DO by logistic regression analysis. No single NIHSSS cutoff with acceptable sensitivity and specificity could be derived to differentiate PO from DO. *Conclusions:* Although NIHSSS are higher in PO, there is no satisfactory NIHSSS cutoff which differentiates PO from DO. A vascular imaging or transcranial doppler should be obtained to determine the site of arterial occlusion in acute stroke. **Key Words:** NIHSSS—occlusion—stroke—transcranial Doppler.

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Introduction

All patients with acute stroke should have intracranial and extracranial vascular assessment. The odds of a functional recovery decrease and those of mortality increase with the presence and increasing proximity of an intracranial arterial occlusion.[1-5] The site of arterial occlusion is one of the main predictors of outcome after intravenous (IV) thrombolysis.[6-8] Patients with proximal arterial occlusions (PO) have lesser chance of achieving recanalization and good clinical outcome than those with distal arterial occlusions (DO).[7-9] Now there is evidence for endovascular treatment in acute stroke with PO making

it a necessity to identify patients with PO in the therapeutic windows at the earliest.[10-14]

One of the ways of identifying a PO in acute stroke is by National Institutes of Health Stroke Scale score (NIHSSS). Studies using digital subtraction angiography (DSA) as the gold standard have suggested that NIHSSS greater than or equal to 12 is predictive of a PO,[15] and NIHSSS greater than or equal to 10 is predictive of an intracranial large-vessel occlusion.[15,16] However, other vascular imaging studies have shown that although NIHSSS is higher in patients with PO as compared to DO, the range of NIHSSS in either case is wide and overlapping.[2,17] Clinical circumstances of deceivingly low NIHSSS in patients with PO assert to this.[18,19] Therefore, predicting a PO solely on the basis of NIHSSS without a vascular imaging can be inaccurate and holding thrombolytic therapy in patients with mild stroke and underlying large-vessel occlusion can lead to early neurological worsening.[20,21]

Apart from computed tomography angiography (CTA), magnetic resonance angiography, and DSA, transcranial doppler (TCD) can be used to assess the intracranial arterial status in the setting of acute stroke. The sensitivity and specificity of TCD are comparable to those of DSA and CTA.[22-26] TCD is a unique tool for assessing the real time cerebral hemodynamics in an acute stroke setting.[23] In addition it is cheap, portable, and safe by not requiring any contrast agent.

In the present study, by determining the site of arterial occlusion using TCD, we aimed to study the following: (1) if there is a correlation between the site of occlusion and the NIHSSS at presentation (bNIHSSS); and (2) if there is a bNIHSSS cutoff which can distinguish PO from DO.

Methods

Up to 374 patients from CLOTBUST data bank were included.[27] All patients had an intracranial arterial occlusion on their TCD and received IV recombinant tissue plasminogen activator (rt-PA) within a 3-hour window. Eighteen patients received IV rt-PA in 3- to 6-hour window in 1 center based on locally approved protocol. The study was approved by local institutional review committees and all subjects gave informed consent.

TCD Procedure

Before the IV rt-PA bolus, an experienced sonographer (registered vascular technologist, MD with American Society of Neuroimaging Certification in Neurosonology, or MD who is an American Society of Neuroimaging-eligible with TCD practice track over 1 year) identified residual flow signals at the presumed thrombus location using the thrombolysis in brain ischemia (TIBI) flow grading system.[28] The depth that displayed the worst residual TIBI flow signal was selected. A 2-MHz transducer was positioned at a constant angle of insonation with a standard head frame. Patients were included in this study if they had a demonstrable occlusion of any of the following intracranial arteries: terminal internal carotid artery (TICA), M1 and M2 segments of middle cerebral artery (MCA), tandem ICA and MCA, anterior cerebral artery (ACA), posterior cerebral artery (PCA), basilar artery (BA), and vertebral artery (VA), according to previously validated criteria.[22,29] TICA, M1 MCA, and BA occlusions were classified as PO whereas M2 MCA, ACA, PCA, and VA occlusions were classified as DO. Complete recanalization was defined as occurrence of TIBI flow grade 4 or 5, as per previously validated criteria.[30]

Clinical Data

NIHSSS at presentation (termed as baseline NIHSSS [bNIHSSS]) and NIHSSS 2 hours after rt-PA bolus were recorded by the treating neurologist who was not involved in the diagnostic TCD, but who was informed about worsening of the blood flow signals on TCD, if these occurred. NIHSSS at 24 hours and modified Rankin Scale (mRS) score at 3 months were obtained by a neurologist who was not blind to the TCD findings. All neurologists who performed serial neurologic examinations were certified in the NIHSS scoring system. In case of clinical worsening within 24 hours after IV rt-PA, a noncontrast computed tomography (CT) head was ordered and an NIHSSS was obtained at the same time.

Statistical Analysis

Of the initially included 374 patients, 61 with tandem ICA/MCA occlusions were excluded from all analyses, because the site of MCA occlusion in the patients (M1 or M2) was unclear due to the presence of a more proximal ICA occlusion that could interfere with the TCD interpretation of the intracranial occlusion, and DSA or CTA was not done to confirm the type of occlusion as being M1 or M2. Therefore, the final analysis was performed on 313 patients.

Univariate analysis based on the different sites of occlusion was done and included all clinical parameters at baseline and at 3 months follow-up, all observed TCD parameters and ASPECTS (Alberta Stroke Program Early CT Score). Univariate and multivariate logistic regression analyses were then performed to define the predictors of PO by including only the baseline clinical parameters, TIBI flow grade, ASPECTS score, and other baseline investigations. Logistic regression analysis was finally performed with predefined arbitrary bNIHSSS cutoffs of greater than or equal to 5, 10, 15, 20, and 25 to determine the sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of each cutoff to predict PO. For each cutoff, the odds ratio (OR) of predicting a PO was calculated in reference to the score below that cutoff. For example, the OR for NIHSSS greater than