Alberta Stroke Program Early CT Score-Time Score Predicts Outcome after Endovascular Therapy in Patients with Acute Ischemic Stroke: A Retrospective Single-Center Study

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Background: Clinical outcomes after successful endovascular therapy in patients with acute ischemic stroke are associated with several factors including onset-to-reperfusion time (ORT), the National Institute of Health Stroke Scale (NIHSS) score, and the Alberta Stroke Program Early CT Score (ASPECTS). The NIHSS-time score, calculated as follows: [NIHSS score] × [onset-to-treatment time (h)] or [NIHSS score] × [ORT (h)], has been reported to predict clinical outcomes after intravenous recombinant tissue plasminogen activator therapy and endovascular therapy for acute stroke. The objective of the current study was to assess whether the combination of the ASPECTS and the ORT can predict the outcomes after endovascular therapy. *Methods:* The charts of 117 consecutive ischemic stroke patients with successful reperfusion after endovascular therapy were retrospectively reviewed. We analyzed the association of ORT, ASPECTS, and ASPECTS-time score with clinical outcome. ASPECTS-time score was calculated as follows: [11 – ASPECTS] × [ORT (h)]. *Results:* Rates of good outcome for patients with ASPECTS-time scores of tertile values, scores 5.67 or less, scores greater than 5.67 to 10.40 or less, and scores greater than 10.40, were 66.7%, 56.4%, and 33.3%, respectively ($P < .05$). Ordinal logistic regression analysis showed that the ASPECTS-time score (per category increase) was an independent predictor for better outcome (common odds ratio: .374; 95% confidence interval: .150-0.930; $P < .05$). *Conclusions:* A lower ASPECTS-time score may predict better clinical outcomes after endovascular treatment.
Key Words: Ischemic stroke—endovascular therapy—outcome predictive factors—endovascular recanalization—revascularization.

Introduction

A series of recent studies and a meta-analysis of these data have shown the benefits of acute endovascular therapy for large vessel occlusion with ischemic stroke.[1-6] Clinical outcomes after endovascular reperfusion therapy for acute ischemic stroke are time-dependent. A meta-analysis of these trials including 1287 patients showed that the benefits of endovascular thrombectomy diminished with a prolonged time period between the onset of stroke and initiation of treatment.[7] A lower National Institutes of Health Stroke Scale (NIHSS) score and a higher Alberta Stroke Program Early CT Score (ASPECTS) are

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Received October 11, 2017; revision received October 22, 2017; accepted November 4, 2017.

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1052-3057/$ - see front matter

https://doi.org/10.1016/j.jstrokecerebrovasdis.2017.11.007

also associated with better outcomes after successful revascularization.[6,8]

Aoki et al reported that, in intravenous recombinant tissue plasminogen activator (IV-rtPA) therapy, the NIHSS-time score, calculated as [NIHSS score] × [onset-to-treatment time (h)], was independently associated with stroke outcomes.[9] In addition, we demonstrated that the NIHSS-time score, calculated as [NIHSS score] × [onset-to-reperfusion time (ORT) (h)], was independently associated with functional outcomes in endovascular reperfusion therapy.[10] The objective of the current study was to assess whether the combination of the ASPECTS and the ORT can predict the outcomes after endovascular therapy.

Materials and Methods

The records of consecutive ischemic stroke patients with successful reperfusion after endovascular therapy, between June 2006 and January 2016 at a single institute (Kobe City Medical Center General Hospital, Kobe, Japan), were retrospectively analyzed. A total of 117 patients were analyzed. Given the retrospective enrollment of each patient in this study, written informed consent for participation was waived. This strategy is in accordance with the guidelines for epidemiological studies issued by the Ministry of Health, Labor and Welfare of Japan. The institutional review board of Kobe City Medical Center General Hospital approved this study.

In our clinical practice until April 2015, magnetic resonance imaging (MRI) scans were performed immediately after the initial plain computed tomography (CT) scans in our institute. In the presence of smaller ischemic lesions on diffusion-weighted images (DWI) than expected from the symptom severity and occluded vessels on magnetic resonance angiography, the suitability for endovascular reperfusion therapy was assessed by at least 3 neurologists/neurosurgeons immediately after the scans. Since May 2015, CT angiography (CTA) instead of MRI has been performed immediately after the CT scan in patients within 4.5 hours of onset. In the presence of smaller early-ischemic changes on initial CT images than expected from the symptom severity and occluded vessels on CTA, the suitability for endovascular reperfusion therapy was assessed by at least 3 neurologists/neurosurgeons immediately after the scans as described above. If all of the physicians had agreed with the therapy, written informed consent from each patient was obtained, and endovascular reperfusion therapy was performed.

Among 3517 patients with acute ischemic stroke, 358 patients underwent endovascular reperfusion therapy. Of those, 117 patients met the following criteria: onset-to-puncture time 8 hours or less and thrombolysis in cerebral infarction score 2b or more[11] were retrospectively analyzed.

Eighty-seven patients met the Japanese guidelines for IV-rtPA therapy and were administered the treatment before endovascular therapy. We performed primarily direct balloon angioplasties before June 2010, and thrombectomies with the Merci Retrieval System (Concentric Medical, Mountain View, CA) between July 2010 and June 2011. Thereafter, between July 2011 and January 2014, we predominantly used the Penumbra System (Penumbra, Alameda, CA), and after February 2014 a stent retriever was used.

The following clinical information was obtained from the medical records: age, gender, ORT, pretreatment NIHSS score, ASPECTS, systolic blood pressure on admission, plasma glucose level, vascular risk factors (hypertension, diabetes mellitus, and atrial fibrillation), occlusion site, adverse hemorrhagic events, and modified Rankin Scale (mRS) score at 3 months. The ASPECTS determined by the neurologist/neurosurgeon before the endovascular treatment was used for the analysis. Good outcomes at 3 months after endovascular therapy were defined as mRS scores of 2 or less. Adverse hemorrhagic events were defined as parenchymal hematoma type 2 (PH-2)[12] and subarachnoid hemorrhage. ORT was defined as the hours between the time that the patient was last seen well and the time at the end of the endovascular therapy. In this study, the ASPECTS-time score was calculated as shown below.

$$[\text{ASPECTS-time score}] = [11 - \text{ASPECTS}] \times [\text{ORT (h)}]$$

For example, the ASPECTS-time score in a patient with an ASPECTS of 8 and an ORT of 4.5 hours was 13.5 (i.e., $[11 - 8] \times 4.5$).

Clinical background characteristics were compared between patients with an mRS of 0-2 and patients with an mRS of 3-6 at 3 months. Continuous variables were analyzed with the Mann–Whitney *U* test and expressed as median values (interquartile range). Categorical data were analyzed using Fisher's exact test and expressed as frequencies (%). The rates of good outcomes were compared among the tertile categories of ORT, 3 categories of ASPECTS, and tertile categories of the ASPECTS-time score. A multivariate ordinal logistic regression analysis was performed to assess the independent association of the ASPECTS-time score with better mRS score adjusted for age, gender, IV-rtPA therapy, NIHSS score, internal carotid artery occlusion, plasma glucose levels, systolic blood pressure on admission, adverse hemorrhagic events, ORT, and the ASPECTS. In addition, a binary logistic regression analysis for the dichotomized mRS score at 3 months was performed to assess the independent association of the ASPECTS-time score with better outcomes adjusted for the above-mentioned factors. Statistical significance was set at $P < .05$. All analyses were conducted with R software using the rms package (version 3.3.1, R Foundation for Statistical Computing, Vienna, Austria).