

Validation of Serial Alberta Stroke Program Early CT Score as an Outcome Predictor in Thrombolysed Stroke Patients

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Background: The Alberta Stroke Program Early CT Score (ASPECTS) on baseline imaging is an established predictor of functional outcome in anterior circulation acute ischemic stroke (AIS). We studied ASPECTS before intravenous thrombolysis (IVT) and at 24 hours to assess its prognostic value. *Methods:* Data for consecutive anterior circulation AIS patients treated with IVT from 2006 to 2013 were extracted from a prospectively managed registry at our tertiary center. Pre-thrombolysis and 24-hour ASPECTS were evaluated by 2 independent neuroradiologists. Outcome measures included symptomatic intracranial hemorrhage (SICH), modified Rankin Scale (mRS) at 90 days, and mortality. Unfavorable functional outcome was defined by mRS >1. Dramatic ASPECTS progression (DAP) was defined as deterioration in ASPECTS by 6 points or more. *Results:* Of 554 AIS patients thrombolysed during the study period, 400 suffered from anterior circulation infarction. The median age was 65 years (interquartile range (IQR): 59-70) and the median National Institutes of Health Stroke Scale score was 18 points (IQR: 12-22). Compared with the pre-IVT ASPECTS (area under the curve [AUC] = .64, 95% confidence interval [CI]: .54-.65, $P = .001$), ASPECTS on the 24-hour CT scan (AUC = .78, 95% CI: .73-.82, $P < .001$), and change in ASPECTS (AUC = .69, 95% CI: .64-.74, $P < .001$) were better predictors of unfavorable functional outcome at 3 months. DAP, noted in 34 (14.4%) patients with good baseline ASPECTS (8-10 points), was significantly associated with unfavorable functional outcome (odds ratio [OR]: 9.91, 95% CI: 3.37-29.19, $P \leq .001$), mortality (OR: 21.99, 95% CI: 7.98-60.58, $P < .001$), and SICH (OR: 8.57, 95% CI: 2.87-25.59, $P < .001$). *Conclusion:* Compared with the pre-thrombolysis score, ASPECTS measured

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at 24 hours as well as serial change in ASPECTS is a better predictor of 3-month functional outcome. **Key Words:** Acute ischemic stroke—CT scan—thrombolysis—ASPECTS.

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Introduction

Acute ischemic stroke (AIS) is a leading cause of dependency.¹ Although rapid advances have occurred in endovascular therapy, these facilities are not readily available at many centers.² Therefore, intravenous thrombolysis (IVT) still remains the primary reperfusion strategy in AIS. Various clinical and radiological assessments are commonly employed for systematic quantification of stroke severity at presentation and at 24 hours for optimal management and early prognostication.^{3,4}

The Alberta Stroke Program Early CT Score (ASPECTS) on the pre-IVT imaging is a simple, rapid, and reliable method to determine the extent of presumed infarcted tissue and cytotoxic edema with high sensitivity and specificity.^{5,6} It has been validated in various intravenous reperfusion strategies to predict functional outcome as well as complications such as symptomatic intracranial hemorrhage (SICH).^{5,7,8} Furthermore, pre-IVT ASPECTS has been suggested as a tool for patient selection for reperfusion strategies.⁹⁻¹¹

Initial stroke severity primarily determines the clinical outcome in patients with AIS.¹² Interestingly, ASPECTS serves well to establish the stroke severity at presentation and matches well with other commonly used clinical scores like the National Institutes of Health Stroke Scale (NIHSS),¹³ Canadian Neurological Scale,¹⁴ and European Stroke Scale.¹⁵ However, the stroke severity measured “after” rather than “before” IVT may be a better predictor of functional outcome.¹⁶ Accordingly, longitudinal change in pre-IVT NIHSS score to the 24-hour score has been shown to be a stronger predictor of functional outcomes compared with the stroke severity at presentation.¹⁷ Because radiological scoring systems estimate the parenchymal damage, serial ASPECTS assessment and their temporal profile may serve as a robust determinant of functional recovery in thrombolized AIS patients. We evaluated this potential association in our anterior circulation AIS cohort.

Methods

Patient Selection and Data Collection

Data for consecutive AIS patients treated with intravenous tissue plasminogen activator and admitted to our tertiary center from 2006 to 2013 were entered in a prospectively maintained registry. All AIS patients underwent non-contrast computed tomography of the brain before IVT and 24 hours after. Stroke subtypes were deter-

mined using the Trial of Org 10172 in Acute Stroke Treatment.¹⁸ NIHSS scores were recorded for all cases by credentialed neurologists before IVT and 24 hours after.

Radiological Scoring and Definitions

Radiological stroke severity was assessed with ASPECTS assessment by 2 independent neuroradiologists with expertise in stroke imaging. ASPECTS is a 10-point quantitative topographic score, which is determined by evaluating 2 standardized regions of the middle cerebral artery territory, the basal ganglia level and the supraganglionic level, for ischemic changes.⁵ These areas were divided into 10 distinct regions, each amounting to 1 point. The maximum ASPECTS was 10 points in patients with no ischemic changes on non-contrast computed tomography. One point was deducted for each area with acute ischemic changes. These changes excluded chronic changes such as leukoaraiosis, established infarcts, or atrophy.⁵ Scoring for pre-IVT and 24-hour CT was performed on the same sitting. ASPECT evaluators were blinded to the clinical data and any discrepancy between them was resolved by consensus. A score of 8-10 points defined good ASPECTS, whereas a score of 0-7 points was considered poor.¹⁹ Change in ASPECTS was also calculated as the 24-hour CT ASPECTS minus the initial ASPECTS. Dramatic ASPECTS progression (DAP) was defined as a reduction in ASPECTS by 6 points or more on the 24-hour CT, when compared with the baseline.²⁰ Functional outcome was assessed by the modified Rankin Scale (mRS) at 90 days. An mRS of >1 was defined as unfavorable functional outcome.²¹ Additionally, we looked at functional independence, defined by mRS 0-2, as a secondary outcome. SICH was defined as the presence of new bleeding on the follow-up CT scan, which was accompanied by an increase in NIHSS by 4 points or more.²²

Statistical Methods

We present the numerical variables as median and range. Categorical variables were presented as percentages. Numerical predictors were assessed using Mann-Whitney *U*-test, and categorical variables were evaluated using chi-square test or Fisher exact test where applicable. Variables that were found to have a significant association ($P < .05$) were entered into the multivariable model to perform logistic regression for determining the independent predictors of the prespecified favorable and unfavorable functional outcome at 90 days. Where applicable, separate multivariate models were used to evaluate the effect of

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