The Prognostic Value of CT-Angiographic Parameters After Reperfusion Therapy in Acute Ischemic Stroke Patients With Internal Carotid Artery Terminus Occlusion: Leptomeningeal Collateral Status and Clot Burden Score

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Background: The objective of this study was to investigate the prognostic value of computed tomographic angiography (CTA) based on leptomeningeal collateral (LMC) status and other parameters in acute ischemic stroke (AIS) patients with internal carotid artery (ICA) terminus occlusion treated with endovascular treatment (EVT).
Methods: All eligible patients from January 2013 to December 2017 undergoing EVT were retrospectively reviewed. The regional leptomeningeal score was used to assess the LMCs on baseline CTA. The collateral status measured by the LMC score (0-20) was trichotomized into 3 groups: good (17-20), intermediate (11-16), and poor (0-10).
Results: Our sample included a total of 119 eligible patients (60 males; mean age, 73 years) with a median baseline National Institute of Health Stroke Scale (NIHSS) score of 14. Patients with a good LMC score had a lower baseline mean NIHSS score, a higher mean Alberta Stroke Program Early CT score, and a higher mean clot burden score (CBS). Baseline NIHSS score <15 (odds ratio [OR] 3.69 95% confidence ratio [CI]: 1.32-10.29, $P = .013$), CBS $\geq$ 6 (OR 3.97 95%CI: 1.05-14.99, $P = .042$), good LMC score (OR 5.14 95%CI: 1.62-16.26, $P = .005$) and successful recanalization (OR 11.55 95%CI: 2.72-48.99 $P = .001$) were independent predictors of good clinical outcomes.
Conclusions: CTA-based LMC status and CBS are powerful predictors of clinical outcomes in patients with an acute ICA terminus occlusion treated with EVT.
Key Words: Leptomeningeal collaterals—computed tomographic angiography—acute ischemic stroke—endovascular treatment

Introduction

Leptomeningeal collaterals (LMCs) are pre-existing anastomoses that cross-connect a small number of distal arterioles within the crown of the cerebral arterial tree.[1,2] These arteriolar connections contribute to retrograde filling of the pial arteries distal to an occlusion site.

Previous studies have demonstrated that a noninvasive LMC scoring system using computed tomographic angiography (CTA) is well correlated with clinical

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outcomes in patients with an acute ischemic stroke (AIS).[3-5] A higher number of LMCs has been associated with improved clinical outcomes and a lower risk of hemorrhagic transformation in patients with CVA; such collaterals have also been associated with a reduction in the initial infarct core size and subsequent infarct growth.[6]

Acute internal carotid artery (ICA) terminus occlusions frequently lead to adverse neurological outcomes and are associated with a high mortality.[7] The poor prognosis associated with ICA terminus occlusions may be partially due to the large thrombus burden precluding successful recanalization. ICA terminus occlusions are rarely recanalized with intravenous thrombolytic therapy alone, and therefore adjunctive endovascular treatment (EVT) has been proposed as an alternative therapy that can achieve recanalization with better rates of success.[8]

In this analysis, we seek to demonstrate the prognostic value and reliability of the LMC score and the length of the thrombus burden in patients with an acute ICA terminus occlusion treated with EVT.

Methods

Patient Enrollment

Our institutional review board approved this retrospective study, and the requirement for patient informed consent was waived for review of patient records and images. Using a database of clinical and radiologic records, we identified patients who presented with an AIS treated with EVT from January 2013 to August 2017. Our study inclusion criteria targeted patients who received a noncontrast computed tomography (NCCT) at the time of admission, followed by a CTA who had a documented ICA terminus occlusion. During this time period, 602 AIS patients were treated with EVT. Of this number, 483 were ineligible for the study; this included 431 patients without an ICA terminus occlusion, 32 patients without an available baseline CTA of adequate quality to evaluate the LMCs, and 20 patients without an initial CTA. Our final sample consisted of 119 patients (Fig 1).

Image Acquisition

Standard NCCT (SOMATOM Sensation 16 or Definition Flash; Siemens, Erlangen, Germany) with 4.5-mm section thickness slices were obtained for all patients. Patients in our sample had an NCCT, followed by a CTA, which was performed by scanning from the cerebral vertex to the aortic arch with .7-mm section thickness slices. Nonionic contrast media (80-120 ml) was administered into the antecubital vein at 3-5 ml/s, and the CTA source images were postprocessed and reformatted to create coronal, sagittal, and axial multiplanar images.

Endovascular Treatment

All eligible patients were given .9 mg/kg of intravenous recombinant tissue plasminogen activator within 4.5 hours of symptom onset. If a large artery occlusion that corresponded to stroke symptoms was identified on the CTA, the patients were brought to the angiography suite for EVT. The manual aspiration technique with a Penumbra aspiration catheter (Penumbra, Alameda, CA) was used as the first-line EVT. If recanalization was not achieved using this technique, stent retrieval with a Solitaire stent system (Covidien, Irvine, CA) was used. Recanalization was assessed using post-procedure angiography and successful recanalization was defined as having a 2b/3 flow as calculated using the Thrombolysis in Cerebral Infarction (TICI) scale.

Clinical and Imaging Analysis

We collected patients' demographic, clinical, and angiographic data from the medical record. We calculated LMC scores from the baseline CTA, which were assessed using a previously reported regional collateral scoring system

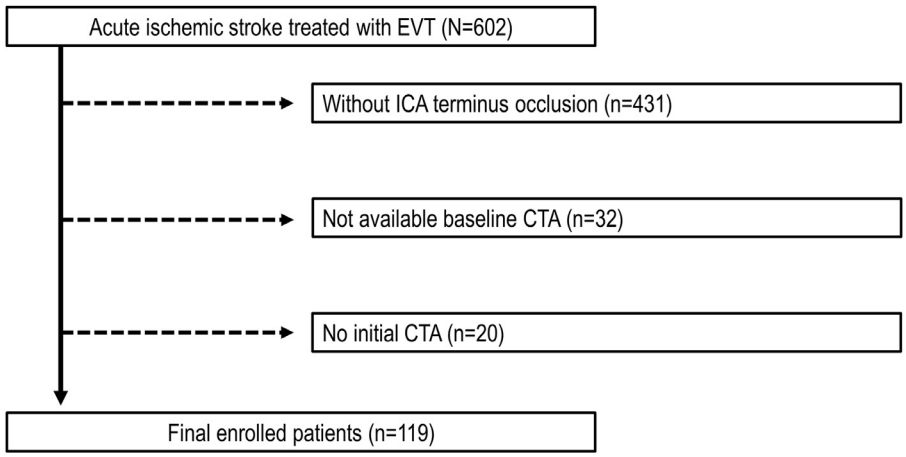

Figure 1. *Flow diagram of the current study.*