Manual Aspiration Thrombectomy
Adjunctive Endovascular Recanalization Technique in Acute Stroke Interventions

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Background and Purpose—We evaluated recanalization rates, clinical outcomes, and safety when manual aspiration thrombectomy is used in conjunction with other thrombolytic modalities in a consecutive case series of patients with large vessel intracranial occlusion.

Methods—We conducted a retrospective review of a prospectively acquired acute endovascular stroke database. Manual aspiration thrombectomy was carried out with Distal Access and Penumbra reperfusion catheters of different sizes placed in the thrombus and aspirated with a syringe.

Results—We identified 191 patients; Occlusion locations were as follows: M1% to 50%, M2% to 10%, internal carotid artery terminus 25%, and vertebrobasilar 15%. Median treatment duration was 90 minutes. Recanalization results were Thrombolysis in Myocardial Ischemia 2/3 93%, Thrombolysis in Myocardial Ischemia 3 71%, Thrombolysis In Cerebral Infarction 2a/2b/3 91%, Thrombolysis In Cerebral Infarction 2b/3 71%, and Thrombolysis In Cerebral Infarction 3 25%. Larger catheters were associated with higher recanalization rates. Parenchymal hematoma rate was 13.6%. The favorable outcome (90-day modified Rankin Scale ≤2) rate was 54%. Mortality at 90 days was 25%.

Conclusions—Manual aspiration thrombectomy is a useful addition to the armamentarium of endovascular treatment modalities for acute stroke. (Stroke. 2012;43:1408-1411.)

Key Words: aspiration ■ endovascular ■ intra-arterial ■ stroke ■ thrombectomy

Recanalization is the strongest predictor of outcome after acute occlusion of large intracranial arteries. Therefore, therapies achieving the highest recanalization rates within the shortest period of time are likely to yield the best clinical outcomes.1 Although manual aspiration thrombectomy is a well-established technique in the coronary literature, there is little experience with this technique in endovascular stroke therapy.2 The aim of this study is to describe procedural, clinical, and safety outcomes observed with the use of this technique at our center.

Methods

Patient Selection

This retrospective study was approved by our Institutional Review Board. Patients presenting with acute ischemic stroke were initially evaluated with MRI or CT. In general, as a first step, patients with anterior circulation strokes were selected for intra-arterial therapy if CT showed an Alberta Stroke Programme Early CT Score >6 or less than one third hypodensity within the middle cerebral artery territory or based on assessment of mismatch between extent of infarcted brain relative to threatened but viable brain. Time from stroke onset was not considered a limiting factor.3

Treatment Algorithm

On visualization of an occlusive lesion on digital subtraction angiography, intra-arterial therapy was initiated (Figure). Conscious sedation was used in preference to general anesthesia. For patients who did not receive intravenous tissue-type plasminogen activator, heparin was given as a bolus of 2000 U unless otherwise contraindicated. Activated clotting times were not routinely monitored. A triaxial system consisting of the aspiration catheter (Distal Access Catheter or Penumbra), 18-L microcatheter (Concentric Medical, Mountain View, CA), and 0.014-inch guidewire was used. The 18-L microcatheter was then advanced distal to the clot to deploy the Merci Retriever (Concentric Medical) and the aspiration catheter was advanced into the thrombus. The Merci retriever and microcatheter were then pulled into the aspiration catheter and removed from the body. Subsequently, at the same time as slowly retracting the aspiration catheter into the base catheter, continuous manual aspiration with a 20-mL syringe attached to the proximal end of the aspiration catheter was carried out. One of 4 catheters, which included the 0.044-inch or 0.057-inch Distal Access Catheter (Concentric Medical) and the 0.041 or 0.054-inch Penumbra aspiration catheters (Penumbra Inc, Alameda, CA), was used depending on the tortuosity of the proximal anatomy, size of the occluded vessel, and availability because larger-bore catheters only became commercially available at a later date. When all 4 catheters were available, preference was given to the largest catheter. Recanalization (Throm-
bolysis in Myocardial Ischemia and Thrombolysis in Cerebral Infarction scores) was recorded prospectively at the end of each case by the treating interventionalist and was deemed successful if postprocedure angiography revealed Thrombolysis in Myocardial Ischemia (TIMI) 2 or Thrombolysis in Cerebral Infarction (TICI) 2 flow.

Statistics
Statistical analysis was performed using the STATA IC 10 software (StataCorp LP, College Station, TX). Descriptive statistics were obtained. In univariate analysis, several variables of interest were correlated to good functional outcome. For each end point, all covariates with a probability value <0.2 were then entered into a multivariate stepwise logistic regression model. Significant association was considered for a probability value of <0.05.

Results
Between November 2008 and April 2011, 191 patients with an acute stroke secondary to a large vessel occlusion were treated with manual aspiration thrombectomy and were included in the analysis (Table). A large-diameter catheter (≥0.054 internal diameter) was used in 67%. This type of catheter was used exclusively in 45% of cases. The incidence of parenchymal hemorrhage (1/2) was 13.6% (26 of 191). This included 5 patients (2.6%) who experienced perforation of the intracranial vessel treated. A significant association between catheter diameter and likelihood of recanalization was found when a large-diameter catheter (0.057 Distal Access Catheter or 0.054 Penumbra) was used with a successful recanalization rate (more than Thrombolysis in Cerebral Infarction 2B) of 75.6% versus 60.3% when compared with the use of a smaller catheter (P=0.040). Short treatment duration was significantly associated with the likelihood of achieving a good clinical outcome. Patients with good outcomes achieved recanalization in 86 minutes compared with 113 minutes in patients with a poor outcome (P=0.0002).

In multivariate analysis, factors significantly associated with favorable outcome were found to be admission National Institutes of Health Stroke Scale score (OR, 0.89; 95% CI, 0.85–0.94; P<0.001), successful recanalization Thrombolysis in Cerebral Infarction ≥2B (OR, 7.83; 95% CI, 2.88–21.3; P<0.0001), age (OR, 0.94; 95% CI, 0.90–0.97; P=0.002), baseline Alberta Stroke Programme Early CT Score (OR, 1.89; 95% CI, 1.25–2.85; P=0.004), history of hypertension (OR, 0.15; 95% CI, 0.04–0.57; P=0.019), M1 occlusion location (OR, 3.3; 95% CI, 1.3–8.63; P=0.016), and intubation (OR, 0.23; 95% CI, 0.07–0.74; P=0.008).

Discussion
In the pooled analysis of the Mechanical Embolus Removal in Cerebral Ischemia (MERCI) and Multi MERCI trials, the rate of successful revascularization (Thrombolysis in Myocardial Ischemia 2 and 3) was 64% with favorable outcomes observed in 32.4% of patients and a 90-day mortality of 38%. The Penumbra pivotal resulted in successful revascularization rates of 82% with favorable outcomes observed in 25% of patients and a 90-day mortality of 33%. In the MERCI, Multi MERCI, and Penumbra trials, symptomatic intracerebral hemorrhage rates varied from 7.8 to 11.2%. Our results compare favorably.

It should be noted that most cases involved aspiration preceded by some form of mechanical clot manipulation, which primarily consisted of the Merci device. It is possible that deployment of the device facilitated aspiration by disrupting/compressing the clot and making it more amenable to suction or by pulling the clot into the suction catheter’s distal end. Initially, this was the intention; however, greater comfort with advancement and deployment of the suction catheters led to the use of manual aspiration thrombectomy either with
a limited use or without the Merci device as evidenced by a median number of 1.3 Merci passes, which is substantially lower than that used in the MERCI/Multi MERCI trials.9,10 Because the largest catheters (0.054 or 0.057) can be difficult to advance past the cavernous or supraclinoid carotid artery, deployment of the Merci device distal to the clot often facilitates advancement of these large catheters to the clot interface by simply providing a stabilizing or tethering effect of the microcatheter. This technique, recently described by Penumbra aspiration system users,11 oftentimes represented the main reason why the Merci device was used in our group of patients. Our findings, based on a single-center retrospective study involving patients with similar vascular occlusion sites, suggest that when used as part of a multimodality recanalization strategy, manual aspiration thrombectomy is associated with favorable recanalization rates, clinical outcomes, and equivalent safety profiles compared with other mechanical revascularization methods currently approved for use in the United States. Clinical efficacy of this approach compared with standard medical therapy remains to be demonstrated in prospective, randomized controlled trials.

**Disclosures**

T.J. has received consulting and speaker fees from Co-Axia, ev3, Concentric Medical, and Micrus.
References
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Stroke. 2012;43:1408-1411; originally published online March 1, 2012;
doi: 10.1161/STROKEAHA.111.646117
Stroke is published by the American Heart Association, 7272 Greenville Avenue, Dallas, TX 75231
Copyright © 2012 American Heart Association, Inc. All rights reserved.
Print ISSN: 0039-2499. Online ISSN: 1524-4628

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://stroke.ahajournals.org/content/43/5/1408

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