Does Modern Ischemic Stroke Therapy in a Large Community-Based Dedicated Stroke Center Improve Clinical Outcomes? A Two-Year Retrospective Study

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Background: To compare modern endovascular therapies in the acute ischemic stroke patients leading to more comprehensive acute stroke algorithm. *Methods:* A 2-year retrospective nonrandomized study on 76 patients who were placed into 5 different treatment groups for acute ischemic stroke. These groups included: group 1 (no treatment) (n = 24), group 2 (intravenous tissue plasminogen activator [tPA] only) (n = 18), group 3 (intra-arterial [IA] tPA) (n = 9), group 4 (Mechanical Embolus Removal in Cerebral Ischemia [MERCI]; retrieval only) (n = 17), and group 5 (combined IA/MERCI) (n = 8). Age range for all groups was 29-92 years. There were 39 women (51.3%) and 37 men (48.7%). The mean age for all patients was 70.1 years. The pre- and post–National Institutes of Health Stroke Scale (NIHSS) values were obtained for each group on arrival and discharge from the hospital. The results of the 4 treatment cohorts were compared with the no treatment group, providing the relative efficacy of these procedures compared with conservative medical therapy alone. *Results:* Group 1 presented with an admission NIHSS value of 11.1 and 8.9 on discharge from the hospital. There was a NIHSS reduction of 2.2 without treatment. Group 2 had an admission NIHSS value of 11.8 and a discharge value of 4.7, resulting in an NIHSS reduction of 7.1. Group 3 had an admission NIHSS value of 16.1 and 7.4 at discharge, resulting in an NIHSS reduction of 8.7. Group 4 had an admission NIHSS value of 15.9 and discharge NIHSS value of 3.1, with an NIHSS reduction of 12.8. Group 5 had an admission NIHSS score of 15.7 and 10.6 at discharge, with an NIHSS reduction of 5.1. Four patients expired during their admission, 2 from group 1 (control group) and 2 from group 5 (combined IA/MERCI group). There was a statistically significant difference for the 5 groups at the $P < .05$ level in change in NIHSS scores: F (4, 24) = 9.10, $P = .000$. *Conclusions:* Modern endovascular therapies for acute ischemic stroke do improve clinical outcomes when implemented in the setting of a dedicated comprehensive stroke team. **Key Words:** NIHSS—tPA—penumbra—MERCI—CT perfusion.

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Introduction

Stroke remains the third leading cause of death and the first leading cause of serious long-term disability in the United States.[1,2] On average, someone suffers a stroke every 45 seconds and someone dies every 3-4 minutes.[1] A total of 780,000 strokes occur each year in the United States. More than 20% of stroke survivors will require institutional care within 3 months of the event.[2] Stroke is defined as a sudden and severe attack. It is broadly divided

into 2 categories. The ischemic stroke consists of an abrupt blockage of blood flow to the brain. A hemorrhagic stroke is bleeding into or around the brain. Eighty-seven percentage of strokes are ischemic and 13% are hemorrhagic.[1,2] A standard stroke treatment algorithm will give patients the best possible chance for a good outcome. The National Institutes of Health Stroke Scale (NIHSS) enhances neurologic assessment for all patients presenting with stroke symptoms. The modified Rankin Scale (mRS) is a disability score obtained at 90 days to evaluate treatment outcomes after a stroke. The values are calculated from 0-5. This is a reliable and efficient measure of functional outcomes.

Endovascular therapy has become a valuable addition to the acute management of stroke. At most primary stroke centers, intravenous tissue plasminogen activator (IV tPA) is available in the emergency room (ER) to help facilitate clot dissolution within 4.5 hours. If the patient arrives at a dedicated comprehensive stroke center, they can be treated with endovascular therapies up to 8 hours after their event. Endovascular stroke therapy may have an impact on quality of life compared with conservative traditional treatments.

Materials and Methods

This was a single-center 2-year retrospective nonrandomized study comparing stroke outcomes between patients who received various invasive stroke interventions and those who were not eligible to receive invasive treatment but instead were treated conservatively continuing onto palliative care. Institutional Review Board approval was obtained before this retrospective study. Informed consent was obtained from the patients enrolled in the study at the time of onset. Initially, a coordinated stroke team responds to all acute stroke patients. When a "stroke alert" is called, the team is immediately activated into motion. The stroke team immediately evaluates each patient on arrival to the Emergency Department. A diagnostic noncontrast computed tomography (CT) of the brain, stroke scale, time of onset (patient last seen normal), and relevant history are obtained as quickly as possible. Patients were placed into each group based on time of onset, established imaging criteria, and inclusion or exclusion for IV tPA (Fig 1). Each patient's pretreatment NIHSS and discharge NIHSS values were recorded. The pre- and post-NIHSS values were calculated, and the change in the overall stroke scale (Table 1). Ideally, the target time from arriving at the hospital to imaging is 25 minutes and complete imaging results by 45 minutes. All patients received an emergent CT stroke panel of the brain that included a noncontrast CT to rule out hemorrhagic strokes and old ischemic infarcts. CT angiography (CTA) of both the carotid and intracerebral vasculature was performed after evaluation of the noncontrast study. The Circle of Willis was evaluated for presence and location of intraluminal emboli, aneurysm, arteriovenous malformations, thrombotic occlusion, and stenosis. The carotid and vertebral arteries were evaluated for stenosis, occlusion, dissection, and any variant anatomy that may lead to access problems during endovascular intervention. A CT perfusion (CTP) scan was also included in the stroke panel to assess the perfusion to the brain. This evaluated the presence of a penumbra (viable brain) within an infarction amenable to endovascular treatment.

Several treatment options were available depending on the severity and eligibility of the patient (Fig 1). Time of symptom onset was the first factor in determining the eligibility of the patient. If the time of onset cannot be determined, the patient may be ineligible to receive any acute stroke treatment. However, exceptions included those patients where the CTP studies suggested that the brain still contains viable penumbra. Also, a low stroke scale number may not warrant the risks involved in invasive stroke therapy. However, some patients had waxing and waning symptoms particularly in the setting of a large-vessel occlusion where it was likely that the patient will ultimately worsen. In such cases, therapy was warranted.

Patient Population

Seventy-six patients were placed into the 5 categories. The overall age range of all groups was 29-92 years. Group 1 (n = 24) (age range 52-92 years) received no treatment (control group). Group 2 (n = 18) (age range 48-87 years) received only IV tPA (Activase; Genentech, South San Francisco, CA). Groups 3, 4, and 5 were taken to the angiography suite for endovascular treatment. Group 3 (n = 9) (age range 53-82 years) received intra-arterial (IA) thrombolytic therapy only. Group 4 (n = 17) (age range 29-90 years) received mechanical clot removal (Mechanical Embolus Removal in Cerebral Ischemia [MERCI]; Concentric Medical Inc., Mountain View, CA) only. Group 5 (n = 8) (age range 54-86 years) received the combination of both IA and mechanical treatments. All patients followed the same treatment protocols at the time of diagnosis.

CT Perfusion Technique

The General Electric LightSpeed 16 (General Electric Healthcare, Fairfield, CT) was used for all CTP scans during this study. The patient was transported directly to the Radiology Department just adjacent to the ER. CT images were created and reformatted images were generated at a 3-dimensional workstation. Vessel analysis and perfusion scan images were created on a GE Advantage Workstation (General Electric Healthcare). CTP images include cerebral blood flow (CBF), cerebral blood volume (CBV), and mean transit time (MTT) imaging from 1 set of dynamic CT images acquired directly after contrast