Catheter-Based Treatment for Patients With Acute Ischemic Stroke Ineligible for Intravenous Thrombolysis

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Background and Purpose—We present our single-center experience using catheter-based therapy for acute ischemic stroke patients who were not candidates for intravenous thrombolytic therapy.

Methods—Neurologic outcomes were assessed in patients with acute ischemic stroke, ineligible for intravenous thrombolysis, treated with an emergent catheter-based therapy.

Results—Nonparametric analysis of neurological outcomes demonstrated a benefit in National Institutes of Health Stroke Scale (NIHSS) at long-term follow-up (P=0.036). Independence in daily activities and improvement in NIHSS of ≥4 points were achieved in 38% and 56% of patients, respectively. Four patients (25%) died, including 2 patients (12.5%) who died from intracranial hemorrhage.

Conclusions—Catheter-based treatment offers a promising treatment strategy in patients with acute ischemic stroke ineligible for intravenous thrombolysis. (Stroke. 2004;35:e109-e111.)

Key Words: stroke, acute ■ stroke management ■ thrombolysis

Intravenous thrombolytic therapy improves independent survival in patients with acute ischemic stroke.\(^1\,^2\) However, <5% of patients with ischemic stroke receive systemic thrombolysis.\(^3\) Intravenous thrombolysis is effective in recanalizing culprit lesions and improving neurological outcomes in acute stroke.\(^4\,^5\) Percutaneous angioplasty, as an adjunct to intravenous thrombolysis, is feasible in acute stroke. We report our experience with emergent catheter-based treatment (CBT) (local thrombolysis and/or mechanical therapy with balloon angioplasty/stenting) for patients with acute ischemic stroke ineligible for intravenous thrombolysis.

Methods

Institutional review board approval was obtained to review the outcome of consecutive patients, between April 1996 and September 2002, with acute ischemic stroke ineligible for intravenous thrombolysis by National Institute of Neurological Disorders and Stroke (NINDS) criteria and treated with CBT strategy. The stroke neurologist in consultation with the interventional cardiologist/neuroradiologist determined appropriateness for CBT. Patients were considered eligible for CBT if they were <7 hours from symptom onset, their National Institute of Health Stroke Scale (NIHSS) was ≥4, and had no evidence of intracranial hemorrhage or involvement more than one third of the middle cerebral artery territory on a computed tomogram. Informed consent was obtained from the patient or their authorized representative.

Culprit lesion characteristics determined the recanalization strategy. After angiography and identification of the culprit lesion, anticoagulation was achieved with intraarterial heparin. Balloon angioplasty and stenting was the primary strategy for stenotic lesions (>90% diameter stenosis and flow limiting), with intraarterial thrombolytic therapy being used in the presence of a thrombotic occlusion. The thrombolytic agent (urokinase or tissue plasminogen activator [t-PA]) was administered via an infusion catheter placed in direct contact with the thrombus. When partial recanalization was achieved with thrombolysis, balloon angioplasty and stent placement were used, at the discretion of the operator, for the management of residual flow limiting stenosis. Neurological outcome was evaluated at discharge, 30 days after presentation and at follow-up using NIHSS. Functional outcome was assessed using the modified Rankin Score. Patients with modified Rankin Score of 0 or 1 were identified as achieving independence in activities of daily living.

All continuous data are reported as mean±SD. The Wilcoxon (rank sums) score was used to assess NIHSS at follow-up compared with presentation. The Student \(t\) test was used to compare NIHSS at presentation and follow-up for patients surviving 30 days to evaluate the magnitude of benefit. \(P<0.05\) was used to define statistical significance.

Results

Twenty-three patients underwent emergent angiography. A culprit lesion was identified in 17 patients (74%). One patient, with complete recovery of neurological function, was
noted to have a nonflow-limiting dissection at angiography, did not undergo any catheter-based intervention, leaving 16 patients undergoing CBT (Table 1). All patients had a major stroke (baseline mean NIHSS of 15.4±6.2 [median 16, range 4 to 33]). The most common reason for ineligibility for systemic thrombolysis was symptom onset >180 minutes (50%), followed by recent surgery (19%), recent gastrointestinal or genitourinary bleeding (19%), and recent arteriotomy at a noncompressible site (12%). The culprit lesion was located in the anterior circulation in 14 patients (87.5%) and in the posterior circulation in 2 patients (12.5%).

Culprit lesion recanalization was initiated at a median of 231 minutes (mean 220±140 minutes, range 40 to 503 minutes) from symptom onset. Culprit lesion recanalization was achieved using direct angioplasty/stenting alone in 3 patients. Seven patients received intraarterial thrombolysis alone and 6 others were treated with a combination of intraarterial thrombolysis with adjunctive balloon angioplasty/stenting. Thrombolysis was performed using urokinase (337 500±37 500 U) in 2 patients and t-PA (15.1±8.0 mg) in 11 patients.

Nonparametric analysis of outcomes with the Wilcoxon test demonstrated a trend toward improvement in the NIHSS at 30 days (P=0.09) and a definite benefit at last follow-up (P=0.036). Figure demonstrates the magnitude of benefit in patients alive at 30 days using Student t test. Nine patients (56%) demonstrated a marked improvement in NIHSS of ≥4 points, including 6 patients (38%) with improvement of ≥10 points. Independence in activities of daily living was achieved in 38% of patients at 30 days and maintained at last follow-up of 8±12 months (median 3 months).

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There were 4 in-hospital deaths (25%), with events occurring at 0 (intracranial hemorrhage), 2 (intracranial hemorrhage), 21 (cardiogenic shock), and 28 (gastrointestinal bleeding) days after presentation. One patient, undergoing coronary artery bypass surgery 5 days before the stroke, had hemothorax requiring chest-tube drainage and blood transfusion.

Discussion

Our single-center experience with acute ischemic stroke patients ineligible for intravenous thrombolysis suggests that CBT can be performed with reasonable safety and efficacy. The neurological severity at presentation of our patients was comparable to that of patients in the intravenous and intra-arterial thrombolytic trials (Table 2). A favorable outcome was achieved in most of our patients, with 56% demonstrating a marked improvement in NIHSS and 38% achieving independent survival at follow-up. The rate of symptomatic intracranial hemorrhage was higher and mortality was comparable to that seen in the intravenous thrombolysis studies, suggesting safety of this strategy.

Our study differs from previous intraarterial studies in 2 regards. First, all of our patients had contraindications to systemic thrombolysis. Second, the recanalization strategy (local thrombolysis and/or mechanistic therapy with balloon angioplasty/stenting) was based on culprit lesion assessment.

The implementation of catheter-based strategy requires a multidisciplinary collaborative approach for patient selection, culprit lesion anatomy assessment, and postintervention management of these patients, as well as an interventional

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### TABLE 1. Demographic and Baseline Characteristics of Patients

<table>
<thead>
<tr>
<th>N of Patients</th>
<th>16</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>7 (44%)</td>
</tr>
<tr>
<td>Mean age±SD (y)</td>
<td>67.5±15.1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>12 (75%)</td>
</tr>
<tr>
<td>Atrial fibrillation</td>
<td>5 (31.25%)</td>
</tr>
<tr>
<td>Previous transient ischemic attack</td>
<td>1 (6.25%)</td>
</tr>
<tr>
<td>Previous stroke</td>
<td>2 (12.5%)</td>
</tr>
<tr>
<td>Dyslipidemia</td>
<td>9 (56.25%)</td>
</tr>
<tr>
<td>Coronary artery disease</td>
<td>8 (50%)</td>
</tr>
<tr>
<td>Cardiomyopathy</td>
<td>4 (25%)</td>
</tr>
</tbody>
</table>

### TABLE 2. Patient Characteristics and Outcome: Comparison With NINDS, STARS, and PROACT II Trials

<table>
<thead>
<tr>
<th>Study (Reference)</th>
<th>No. of Patients in Treatment Arm</th>
<th>Age (y), % Males</th>
<th>Presenting Median NIHSS</th>
<th>Symptomatic ICH, %</th>
<th>% Mortality at Follow-up</th>
<th>Rankin Score 0/1 at Follow-up, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>NINDS–Part 2 (1)</td>
<td>168</td>
<td>69 y, 57</td>
<td>14</td>
<td>6.4</td>
<td>17 (21% in placebo arm at 3 mo)</td>
<td>39</td>
</tr>
<tr>
<td>STARS (2)</td>
<td>389</td>
<td>69 y, 55</td>
<td>13</td>
<td>3.3</td>
<td>13 at 1 mo</td>
<td>35</td>
</tr>
<tr>
<td>PROACT II (4)</td>
<td>121</td>
<td>64 y, 58</td>
<td>17</td>
<td>10</td>
<td>25 at 3 mo</td>
<td>26</td>
</tr>
<tr>
<td>CBT</td>
<td>16</td>
<td>67 y, 44</td>
<td>16</td>
<td>12.5</td>
<td>25 at 1 mo</td>
<td>38</td>
</tr>
</tbody>
</table>

NINDS indicates National Institute of Neurological Disorders and Stroke (NINDS) rt-PA Stroke Study; STARS, Standard Treatment with Alteplase to Reverse Stroke (STARS) Study; PROACT II, Prolyse in Acute Cerebral Thromboembolism II Trial; NIHSS, National Institute of Health Stroke Scale; ICH, Intracranial hemorrhage.
laboratory available 24 hours per day, 7 days per week, 365 days per year. Limitations of this study include its retrospective nature, the relatively small number of patients, and the lack of a comparative group of patients not undergoing CBT.

Conclusions
The use of CBT for patients with acute ischemic stroke ineligible for intravenous thrombolysis is feasible, with safety and efficacy comparable to that seen in trials of acute ischemic stroke eligible patients treated with intravenous thrombolysis. The adoption of CBT for these patients requires further study in a larger group of patients and in additional centers with expertise in the management of these patients, preferably in the setting of a randomized controlled trial.

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References
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