

Current Reperfusion Strategies for Acute Stroke

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KEYWORDS

• Thrombectomy • Brainstem • Reperfusion • Stent

KEY POINTS

- In anterior circulation strokes the impact of successful thrombectomy is greater in the first 3 to 4.5 hours after stroke than in late recanalization after 5 to 8 hours. In posterior circulation and brainstem strokes caused by vertebral or basilar artery (BA) occlusion, recanalization of occluded vessels has a therapeutic window up to 24 h after symptom onset.
- Multimodal computed tomography (CT) includes unenhanced CT, CT angiography (CTA), and CT perfusion. Noncontrast CT can identify intracranial (IC) hemorrhage and detect early signs of acute ischemic stroke. CTA can identify the occlusion site, detect arterial dissection, and grade collateral blood flow, whereas CT perfusion can differentiate between *tissue at risk* and irreversibly damaged brain tissue.
- CT perfusion helps distinction of the infarct core from the penumbra. In the penumbra, autoregulation is preserved, mean transit time (MTT) is prolonged, but cerebral blood volume (CBV) is preserved because of vasodilatation and collateral recruitment as part of the autoregulation process. In the infarct core, autoregulation is lost, MTT is prolonged, and CBV is down.
- In the authors' experience, the most effective reperfusion strategy today is the stent-retriever-based thrombectomy, in cases of large thrombus load, in combination with plain aspiration through a large distal access catheter (DAC). In special groups of patients with extracranial carotid occlusion, arterial dissection, and IC stenosis acute stenting is necessary.
- Complications that can occur during or after the procedure include distal embolization to the same or other vessel territories, dissection of the arteries, and subarachnoid or intracerebral hemorrhage.



Videos of direct clinical examination of a patient with left side hemiplegia due to an MCA occlusion, examples of “hard” thrombi, brachial artery access, recanalization of MCA occlusion with stent-retriever, and treatment of acute atherosclerotic extracranial ICA occlusion accompany this article at <http://www.interventional.theclinics.com/>

INTRODUCTION

Stroke is the most common cause of permanent disability, the second most common cause of dementia, and the third most common cause of death in the Western world.¹ The World Health

Organization estimates that 5.7 million people die from stroke each year. Each year, ≈ 795,000 people experience a new or recurrent stroke (ischemic or hemorrhagic) in the United States and 1 million people in the European Union. Those who survive

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are often burdened with exorbitant rehabilitation costs, lost wages and productivity, limitations in their daily social activity, and significant residual disability.² Given that the aging population of the world is increasing, the statistics of stroke incidence and prevalence will also climb proportionately.

Timely treatment and intervention can minimize long-term disability by salvaging the at-risk penumbra and, consequently, reducing the associated morbidity and mortality. The only known drug therapy for acute ischemic stroke is thrombolysis with recombinant tissue plasminogen activator (t-PA), which has been proved in many clinical trials to be effective in improving clinical outcome and reducing subsequent disability.³ The only improvement in this therapy has been the extension of the 3-h time frame to 4.5 hours in which it can be safely administered.⁴ The number needed to treat, even with the extended window of 3 to 4.5 hours, is still 14.

A key advantage of intravenous (IV) t-PA is that it can be started rapidly after clinical assessment and CT of the brain without the use of contrast material. However, fewer than 15% to 40% of patients with acute stroke arrive at the hospital early enough to receive thrombolytic treatment, and only 2% to 5% of patients actually receive it.⁵ Limitations of IV t-PA include dependence on available serum plasminogen, the resistance of a large thrombus to fibrinolysis, and the risks of systemic and cerebral hemorrhage.^{6,7}

About 20% of strokes are due to large-artery occlusions causing severe strokes. IC arterial occlusion is independently associated with poor functional outcomes and high mortality rates. The treatment of these patients still remains a challenge because IV thrombolysis often reaches its limit of effectiveness. IV thrombolysis on its own leads to a good clinical outcome (modified Rankin Scale [mRS] ≤ 2) in only 15% to 25% of these cases compared with 40% good clinical outcome in minor strokes.^{8,9} For this reason, patients with IC occlusion are considered to be candidates for additional or primary intra-arterial (IA) therapies.¹⁰

IA treatments for ischemic stroke that are approved by guidelines include IA fibrinolysis until 6 h after onset and mechanical thrombectomy until 8 h after onset.¹¹

INDICATIONS AND PATIENT SELECTION

Important features of the patient's clinical presentation that influence endovascular treatment decisions include clinical status, time of presentation, and imaging characteristics.

Clinical Status

The National Institutes of Health Stroke Scale (NIHSS), a quantitative measure of the severity of the stroke, should be used for assessment during the initial examination in all patients with stroke, but especially in patients being considered for IV t-PA.¹¹ Strokes that are graded 0 to 3 on the scale are considered minor; 4 to 7, mild; 8 to 15, moderate; and greater than 15, severe. Patients with scores greater than 20 are less likely to benefit from any reperfusion treatment.^{1,12} Patients with scores between 8 and 20 are more likely to benefit from reperfusion, making them better candidates for treatment.^{2,13} Patients with minor to mild symptoms (NIHSS score < 8) and an existing IC large-vessel occlusion can also be treated by mechanical thrombectomy; in these patients, the decision to perform additional IA therapy is based on the operators experience and the estimated risk of the procedure.

Time of Presentation

IV t-PA and IA reperfusion therapies have both been shown to improve patient outcome. However, the time window for treatment of both approaches is limited. IV thrombolysis can be given up to 4.5 hours after stroke onset; additional or primary IA therapies can be used up to 8 hours after stroke onset. However, outcome depends on the length of time between onset of symptoms and revascularization.^{3,14,15} Analysis of pooled data from six large randomized t-PA trials showed greater neurologic improvement at 90 days with earlier t-PA treatment.^{4,16} The therapeutic benefit of t-PA is greatest when given early after ischemic stroke onset and declines over 3 to 4.5 hours.^{4,5}

In anterior circulation strokes, the impact of successful thrombectomy is greater in the first 3 to 4.5 hours after stroke, compared to late recanalization after 5 to 8 hours.^{6,7,17} Posterior circulation and brainstem strokes caused by vertebral or BA occlusion may be less susceptible to the hemorrhagic complications of reperfusion therapy. Safe recanalization of occluded posterior circulation vessels has been reported up to 24 h after brainstem infarction.^{8,9,18}

Imaging of Acute Stroke

Imaging in patients with acute stroke should be targeted toward assessment of the brain parenchyma, pipes, perfusion, and penumbra, as described by Rowley^{10,19} and summarized in [Table 1](#). This approach enables the detection of IC hemorrhage, differentiation of infarcted tissue from salvageable tissue, identification of arterial occlusion, selection

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