

Stroke occurs when blood circulation to an area of the brain is suddenly disrupted, leading to a loss of neurologic function. It may be hemorrhagic or ischemic. Acute ischemic stroke, caused by thrombosis or embolism, accounts for at least 59% of all strokes.^[1]

Based on the system of categorizing stroke developed in the multicenter Trial of Org 10172 in Acute Stroke Treatment (TOAST),^[2] ischemic strokes may be any of 3 subtypes:

- Large artery infarction by atherosclerotic lesions in the carotid, vertebrobasilar, and cerebral arteries, typically proximal to major branches;
- Small-vessel, or lacunar, infarction;
- Cardioembolic infarction, a common source of recurrent stroke.

Considered a major advance in the neuroimaging of stroke, MRI with magnetic resonance angiography (MRA) provides structural as well as vascular information. An evidence-based guideline from the American Academy of Neurology recommends that diffusion-weighted imaging (DWI) should be performed for the most accurate diagnosis of acute ischemic stroke.^[3]

OPTIMIZED PROTOCOL

The Department of Radiology at University of Wisconsin-Madison utilizes the following protocol option with a split-dose dynamic gadolinium injection to assess stroke. One practical way to help organize and recall each of the key steps is to remember the 4 Ps of stroke: parenchyma, pipes, perfusion, and penumbra.^[4] Proprietary technologies (eg, TRICKS™ [3D time-resolved imaging of contrast kinetics angiography] and BRAVO™ [3D brain volume sequence]) noted in the protocol are available from GE Healthcare.

Field Strength: 1.5T or 3.0T

PRECONTRAST SERIES

- Multiplanar localizer
- 2D diffusion-weighted imaging (axial, b = 1000)
- 2D axial fat-suppressed T2-weighted
- 2D axial T2-weighted gradient echo (GRE)
- 3D time-of-flight (TOF) MRA – intracranial
- 2D TOF MRA neck – fast localizer protocol
- 3D TOF MRA neck – carotid bifurcations

INJECTION 1: TRICKS™ MRA

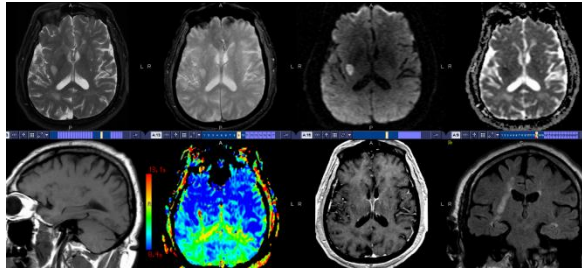
- **Dose:** 0.05 mmol/kg body weight, up to 7 mL maximum
- **Injection rate:** 2 mL/sec followed by 20 mL of saline chaser injected at 2 mL/sec
- **Scan:** Coronal TRICKS™ MRA from arch to vertex, with MIP reconstructions at best phase

INJECTION 2: PERFUSION

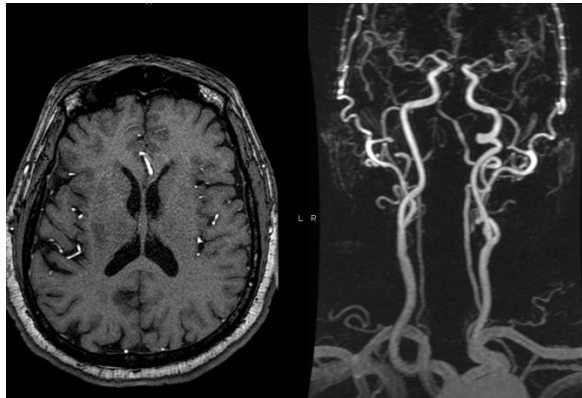
- **Dose:** 0.1 mmol/kg body weight, or up to 13 mL maximum (20 mL maximum for both injections)
- **Injection rate:** 4 mL/sec followed by 20 mL of saline chaser injected at 4 mL/sec
- **Scan:** Simultaneous injection and data acquisition with echo planar images (EPI) used for dynamic susceptibility contrast perfusion

POSTCONTRAST SERIES

- T2-weighted fluid attenuated inversion recovery (FLAIR; either sagittal 3D Cube™ or 2D coronal)
- T1-weighted gradient echo volume (BRAVO™, which creates images in 3 to 4 minutes)



Sample images from this optimized stroke exam are shown above. From left to right, the top row consists of a fat-suppressed T2-weighted image, T2-weighted GRE, diffusion-weighted image, and apparent diffusion coefficient map. The bottom row, left to right, shows a precontrast T1-weighted image, map of first-moment transit time from the DSC perfusion series, postcontrast T1 in the axial plane, and a coronal T2 FLAIR. These key series are completed in less than 20 minutes using a Signa HDxt scanner (GE Healthcare; Waukesha, Wisconsin) operating at 3.0T.



The above images show the postcontrast axial image compared to the TRICKS™ MRA. An infarct is evident on DWIs, perfusion maps, and the postcontrast series. Images are provided courtesy of Howard Rowley, MD, chief of neuroradiology, University of Wisconsin School of Medicine and Public Health.

References

1. Shiber JR, Fontane E, Adewale A. Stroke registry: hemorrhagic vs ischemic strokes. *Am J Emerg Med.* 2010;28:331-333.
2. Adams HP Jr, Bendixen BH, Kappelle LJ et al. Classification of subtype of acute ischemic stroke. Definitions for use in a multicenter clinical trial. TOAST. Trial of Org 10172 in Acute Stroke Treatment. *Stroke.* 1993;24:35-41.
3. Schellinger PD, Bryan RN, Caplan LR, et al. Evidence-based guideline: the role of diffusion and perfusion MRI for the diagnosis of acute ischemic stroke: report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. *Neurology.* 2010;75:177-185.
4. Rowley HA. The four Ps of acute stroke imaging: parenchyma, pipes, perfusion, and penumbra. *AJNR Am J Neuroradiol.* 2001;22; 599-601.

Abbreviations

BRAVO™	3D brain volume sequence
DSC	dynamic susceptibility contrast
DWI	diffusion-weighted imaging
EPI	echo planar image
FLAIR	fluid-attenuated inversion recovery
GRE	gradient echo
MIP	maximum intensity projection
MRA	magnetic resonance angiography
TOAST	Trial of Org 10172 in Acute Stroke Treatment
TOF	time of flight
TRICKS™	3D time-resolved imaging of contrast kinetics angiography