



FIGURE 446-15 Acute left middle cerebral artery (MCA) stroke with right hemiplegia but preserved language. **A.** Computed tomography (CT) perfusion mean-transit time map showing delayed perfusion of the left MCA distribution (*blue*). **B.** Predicted region of infarct (*red*) and penumbra (*green*) based on CT perfusion data. **C.** Conventional angiogram showing occlusion of the left internal carotid–MCA bifurcation (*left panel*), and revascularization of the vessels following successful thrombectomy 8 h after stroke symptom onset (*right panel*). **D.** The clot removed with a thrombectomy device (L5, Concentric Medical, Inc.). **E.** CT scan of the brain 2 days later; note infarction in the region predicted in **B** but preservation of the penumbral region by successful revascularization.

Cerebral Angiography Conventional x-ray cerebral angiography is the gold standard for identifying and quantifying atherosclerotic stenoses of the cerebral arteries and for identifying and characterizing other pathologies, including aneurysms, vasospasm, intraluminal thrombi, fibromuscular dysplasia, arteriovenous fistulae, vasculitis, and collateral channels of blood flow. Conventional angiography carries risks of arterial damage, groin hemorrhage, embolic stroke, and renal failure from contrast nephropathy, so it should be reserved for situations where less invasive means are inadequate. As reviewed earlier in this chapter, endovascular stroke therapy has not been proven effective in three randomized trials, and this remains an area of ongoing investigation.

Ultrasound Techniques Stenosis at the origin of the internal carotid artery can be identified and quantified reliably by ultrasonography that combines a B-mode ultrasound image with a Doppler ultrasound assessment of flow velocity (“duplex” ultrasound). Transcranial Doppler (TCD) assessment of MCA, ACA, and PCA flow and of vertebralbasilar flow is also useful. This latter technique can detect stenotic lesions in the large intracranial arteries because such lesions increase systolic flow velocity. TCD can assist thrombolysis and improve large artery recanalization following rtPA administration; the potential clinical benefit of this treatment is the subject of ongoing study. TCD can also detect microemboli from otherwise asymptomatic carotid plaques. In many cases, MR angiography combined with carotid and transcranial ultrasound studies eliminates the need for conventional

x-ray angiography in evaluating vascular stenosis. Alternatively, CT angiography of the entire head and neck can be performed during the initial imaging of acute stroke. Because this images the entire arterial system relevant to stroke, with the exception of the heart, much of the clinician’s stroke workup can be completed with this single imaging study.

Perfusion Techniques Both xenon techniques (principally xenon-CT) and positron emission tomography (PET) can quantify cerebral blood flow. These tools are generally used for research (**Chap. 440e**) but can be useful for determining the significance of arterial stenosis and planning for revascularization surgery. Single-photon emission computed tomography (SPECT) and MR perfusion techniques report relative cerebral blood flow. As noted above, CT imaging is used as the initial imaging modality for acute stroke, and some centers combine both CT angiography and CT perfusion imaging together with the noncontrast CT scan. CT perfusion imaging increases the sensitivity for detecting ischemia and can measure the ischemic penumbra (Fig. 446-15). Alternatively, MR perfusion can be combined with MR diffusion imaging to identify the ischemic penumbra as the mismatch between these two imaging sequences (Fig. 446-16).

INTRACRANIAL HEMORRHAGE

Hemorrhages are classified by their location and the underlying vascular pathology. Bleeding into subdural and epidural spaces is