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# Comparative Overview of Brain Perfusion Imaging Techniques

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**Background and Purpose**—Numerous imaging techniques have been developed and applied to evaluate brain hemodynamics. Among these are positron emission tomography, single photon emission computed tomography, Xenon-enhanced computed tomography, dynamic perfusion computed tomography, MRI dynamic susceptibility contrast, arterial spin labeling, and Doppler ultrasound. These techniques give similar information about brain hemodynamics in the form of parameters such as cerebral blood flow or cerebral blood volume. All of them are used to characterize the same types of pathological conditions. However, each technique has its own advantages and drawbacks.

**Summary of Review**—This article addresses the main imaging techniques dedicated to brain hemodynamics. It represents a comparative overview established by consensus among specialists of the various techniques.

**Conclusions**—For clinicians, this article should offer a clearer picture of the pros and cons of currently available brain perfusion imaging techniques and assist them in choosing the proper method for every specific clinical setting. (*Stroke*. 2005;36:2032-2033.)

**Key Words:** computed tomography ■ magnetic resonance imaging ■ tomography, emission computed ■ ultrasonography, Doppler, transcranial ■ perfusion ■ stroke ■ tomography, emission-computed, single-photon

Numerous imaging techniques have been developed and applied to evaluate brain hemodynamics. The main imaging techniques dedicated to brain hemodynamics are positron emission tomography (PET), single photon emission computed tomography (SPECT), Xenon-enhanced computed tomography (XeCT), dynamic perfusion computed tomography (PCT), MRI dynamic susceptibility contrast (DSC), arterial spin labeling (ASL), and Doppler ultrasound. Most of these techniques rely on mathematical models developed at the beginning of the century.<sup>1-4</sup> All these techniques give similar information about brain hemodynamics in the form of parameters such as cerebral blood flow (CBF) or cerebral blood volume (CBV). They use different tracers (diffusible or nondiffusible, endogenous or exogenous) and have different technical requirements. Some are feasible at bedside and others not. The duration of data acquisition and processing

varies from one technique to the other. Brain perfusion imaging techniques also differ by quantitative accuracy, brain coverage, and spatial resolution (Table 1 available online only in the full version of this article at <http://www.strokeaha.org>). These differences constitute as many advantages as drawbacks in various clinical settings.

The goal of this article is a comparative overview of the main brain hemodynamics imaging techniques established by consensus among specialists of the different techniques. For clinicians, this should offer a clearer picture of the pros and cons of available brain hemodynamics imaging methods and assist them in choosing the proper technique for every specific clinical setting. The different imaging techniques are presented according to the same template. A technical description, including what kind of contrast is used and whether radiation is involved, is followed by a discussion of the

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technical requirements. Notably, the duration of a routine study is addressed. Then comes an in-depth discussion of the interpretation of the results, including a description of the underlying mathematical model, the duration of the data postprocessing, the measured parameters, the accuracy of the values in normal parenchymal pixels, in pixels containing large vessels, and in pathological pixels with altered hemodynamics, and the reproducibility of the technique. The feasibility of the technique in children and at bedside is also addressed, as well as the afforded brain coverage and spatial resolution and the minimal time interval between 2 successive studies. Finally, the typical clinical applications are reported, as well as the availability of the technique in the emergency setting.

The full version of this article is available online only at <http://www.strokeaha.org>.

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