possible pervasiveness of the effects. Although a gross respiratory change such as a 30-second breath-hold would be unlikely to occur during a conventional fMR imaging experiment, more subtle respiratory changes could accompany some activation paradigms, particularly those with ''surprise'' components. This could result in MR signal changes secondary to the unanticipated respiratory (or cardiac) responses. Statistical analysis might classify erroneously respiratory responses as noise, false localization of a cognitive task, or a true but secondary phenomenon. The latter possibility reemphasizes the complexity, as well as the richness, of these new functional imaging techniques.

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Imaging Brain Abscesses with Diffusion-Weighted and Other Sequences

With so many pulse sequences now available to image the brain, one has to reflect on what is the most practical way of deriving maximal information in a clinically acceptable period of time. The use of MR imaging keeps expanding, not only providing images of incredible detail but allowing the study of metabolism and physiology. As a result, one could spend hours just studying a single patient.

Diffusion-weighted imaging has been used for evaluation of stroke, tumors, demyelination, and vertebral body compression fractures. It is only logical to attempt to extend its use to patients with brain abscess. If one only uses single-axis diffusion-weighted imaging and one B value, there is no significant time penalty. Nevertheless, many now believe that diffusion-weighted imaging should be obtained in three axes (I_z, I_x, and I_y) and then postprocessed as an expression of its natural logarithm (trace imaging) to reduce the contribution of T2 signal ''shine through.'' In addition, apparent diffusion coefficient (ADC) maps are needed for standardization of the data and for obtaining quantitative information from diffusion-weighted images. ADC maps ideally are produced by using more than two B values. Because these manipulations increase imaging time and generally need off-line post-processing, the question is, when should we use diffusion-weighted imaging? The answer is not simple because diffusion-weighted imaging innovations constantly are discovered.

In this issue of the *AJNR*, Desprechins and colleagues (page 1252) describe the use of diffusion-weighted imaging for characterization of nonspecific ring-enhancing lesions that proved to be abscesses. Although only three patients were studied, their results are impressive. The necrosis within the lesions showed increased signal intensity on diffusion-weighted images and a markedly decreased signal on ADC maps. In similar and recent publications, two different groups of investigators found identical results in a total of six patients (1, 2). Contamination by signal from surrounding edema is not a problem, but abscesses appear slightly larger on diffusion-weighted images than on conventional MR images. This probably represents a summation of the necrotic region and the capsule. Although the capsule of an abscess is generally hypointense on T2-weighted images (assumed to be related to presence of free radicals), the capsule is hyperintense on diffusion-weighted images. The reason for the lack of susceptibility effects from the capsule, leading to signal loss on diffusion-weighted images, is not known. On diffusion-weighted images, the hyperintensity seen in the necrosis probably is related to a restriction of microscopic movement of water molecules as they are contained inside a complex matrix of proteins, inflammatory cells, cellular debris, and bacteria in high-viscosity pus. Additionally, water molecules in abscesses are bound to carboxyl, hydroxyl, and amino groups on surfaces of macromolecules. This also limits their translational movement. This finding was confirmed using ADC maps and thus hyperintense ''shine through'' from T2 relaxation effects does not contribute significantly to the appearance of necrosis on diffusion-weighted images. When ADC maps were generated, a marked reduction in the ADC related to restricted Brownian motion of free water was shown. In contradiction to the utility of diffusion-weighted imaging in the diagnosis of cerebral abscesses, Krabbe at al evaluated one abscess that showed low signal on diffusion-weighted images and increased ADC. Desprechins et al attribute the finding to the technique used, questioning the reported findings. High-grade astrocytomas show low signal on diffusion-weighted images and high ADCs. This is probably because the water molecules in these tumors are allowed a greater degree of freedom in their motion. The so-called necrotic center of a tumor contains a less viscous material composed by less cellular debris and fewer inflammatory cells as well as a more serous fluid (often hemorrhagic). Thus, water molecules are

contained within a less restrictive matrix with fewer macromolecules, allowing greater freedom of motion and consequent loss of signal on diffusion-weighted images. In addition, susceptibility effects from blood products (not appreciated on fast spin-echo T2-weighted images) may result in greater signal dephasing on echo-planar images. Desprechins et al state that abscesses had ADC values approximately 50% lower than infarcts. This observation, while interesting, is not clinically critical because differentiating between an abscess and an infarct is usually not difficult.

Now that we know that diffusion-weighted imaging is useful in the preoperative diagnosis of abscesses, what else is available? At our institution, we have used proton MR spectroscopy (HMRS) for this purpose with a high degree of success. The presence of lactate and lipids is not pathognomonic for abscesses but may be seen in necrotic tissue regardless of its etiology. The presence of acetate, succinate, and cytosolic amino acids is, however, highly suggestive of an abscess. Unfortunately, HMRS requires, at the least, an additional 10 minutes to perform and some patients with cerebral abscesses are very sick and unable to remain still. Gadolinium-perfusion MR imaging also may be performed when trying to differentiate an abscess from a tumor. Calculated relative cerebral blood volume (rCBV) is significantly lower in toxoplasmosis when compared to normal brain, whereas rCBV is elevated in tumor (3). Performing perfusion studies not only requires an echo-planar MR unit but also a power injector (which costs approximately $30,000) and extensive postprocessing of data. Fluid-attenuated inversion recovery images (FLAIR) may be helpful in distinguishing fluid-filled lesions. Lesions containing CSF or CSF-like fluid have low signal intensity whereas lesions containing necrosis, as a consequence of inflammation or tumor, show different characteristics. FLAIR images may be obtained in only 3 to 4 minutes and therefore do not result in a significant prolongation of the examination. If one substitutes FLAIR for T2-weighted images, it is not clear if some specificity (such as the low signal intensity of abscess capsule) will be lost. In reality, many of us use the proton-density images to increase the specificity of our differential diagnosis of cystic lesions. The utility of postcontrast FLAIR images also needs to be determined. Although FLAIR may help differentiate simple cysts from ones with a more complex content, it does not enable separation of an abscess from a necrotic tumor as effectively as diffusion-weighted imaging.

So, given all of these techniques to choose from, what should be done when an abscess is being considered? I prefer diffusion-weighted imaging in combination with routine contrast-enhanced MR imaging. Are ADC maps absolutely necessary? From a purely practical and clinical standpoint, I would have to say, probably not. Trace diffusion-weighted imaging, which may be generated in most units with software provided by the manufacturer, has only a very low degree of contamination from T2 relaxation that affects and provides valuable information regarding diffusion properties of a lesion. The information obtained from diffusion-weighted imaging, combined with a thin rim of low signal intensity on T2-weighted images that enhances in a smooth and homogeneous fashion, should place abscess as the foremost consideration. Although other sequences are available, I tend to choose those that are easiest to perform and, at this time, I believe that diffusion-weighted imaging and routine contrast-enhanced MR imaging are easy to obtain and interpret.

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Intraarterial Thrombolysis for Cerebral Infarction: To Treat or Not to Treat, and How?

The appeal of intraarterial thrombolysis is hard to resist. After spending the last 3 decades watching our cardiologist colleagues save patients from death's door with acute intervention, it appears that it's finally our turn to apply some of these techniques for the benefit of some of the 500,000 new acute stroke patients seen each year. The development of microcatheters, the approval of intravenous tissue plasminogen activator (rt-PA) for acute stroke, and the recent encouraging trial of intraarterial prourokinase has created a palpable new enthusiasm among neuroradiologists and neurologists who finally feel that they can provide something more than supportive care for many of these patients. But who should be treated and, importantly, who should not?

In this issue of the *AJNR*, Jahan et al (page 1291) report the outcome in 26 patients with acute cerebral infarction in whom intraarterial urokinase was used for thrombolysis within 6 hours after the onset