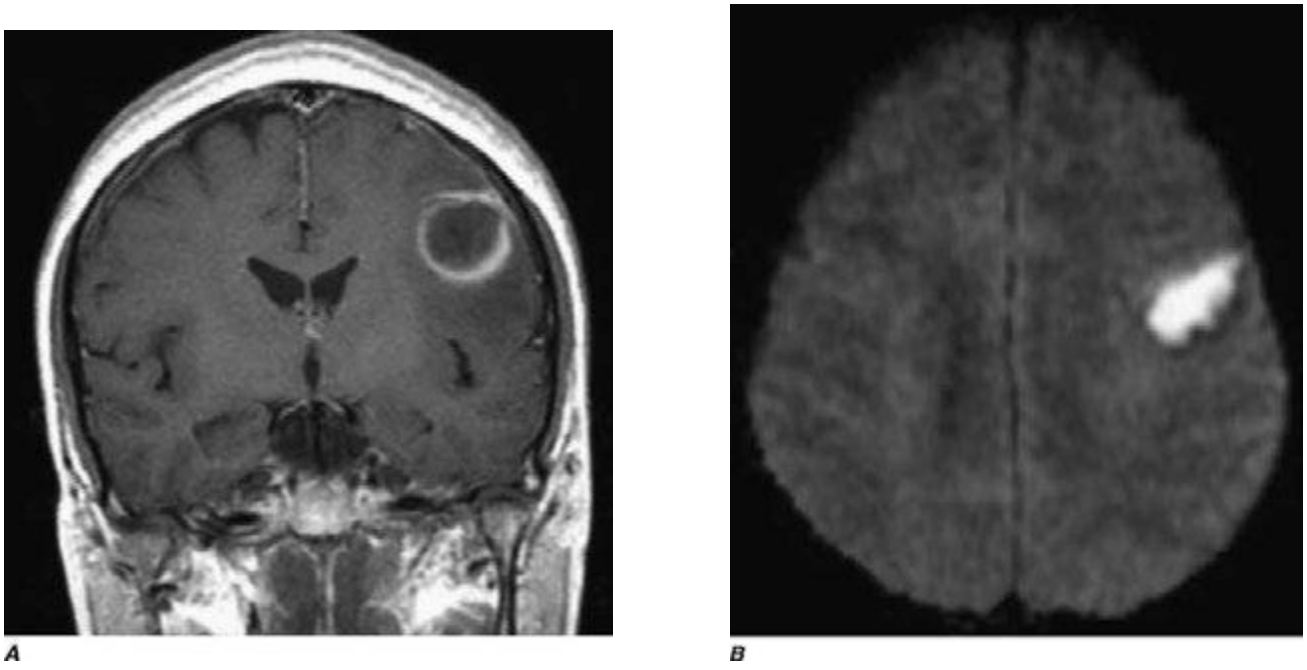

FIGURE 440e-3 **Cerebral abscess in a patient with fever and a right hemiparesis.** ***A.*** Coronal postcontrast T1-weighted image demonstrates a ring-enhancing mass in the left frontal lobe. ***B.*** Axial diffusion-weighted image demonstrates restricted diffusion (high signal intensity) within the lesion, which in this setting is highly suggestive of cerebral abscess.

volume of data that can be reformatted in any orientation to highlight certain disease processes.

MR Contrast Material The heavy-metal element gadolinium forms the basis of all currently approved intravenous MR contrast agents. Gadolinium is a paramagnetic substance, which means that it reduces the T1 and T2 relaxation times of nearby water protons, resulting in a high signal on T1W images and a low signal on T2W images (the latter requires a sufficient local concentration, usually in the form of an intravenous bolus). Unlike iodinated contrast agents, the effect of MR contrast agents depends on the presence of local hydrogen protons on which it must act to achieve the desired effect. There are nine different gadolinium agents approved in the United States for use with MRI. These differ according the attached chelated moiety, which also affects the strength of chelation of the otherwise toxic gadolinium element. The chelating carrier molecule for gadolinium can be classified by whether it is macrocyclic or has linear geometry and whether it is ionic or nonionic. Most of these are excreted by the renal system. Cyclical agents are less likely to release the gadolinium element, and thus are considered the safest category.

ALLERGIC HYPERSENSITIVITY Gadolinium-DTPA (diethylenetriaminepentaacetic acid) does not normally cross the intact BBB immediately but will enhance lesions lacking a BBB (Fig. 440e-3*A*) as well as areas of the brain that normally are devoid of the BBB (pituitary, dura, choroid plexus). However, gadolinium contrast has been noted to slowly cross an intact BBB over time and especially in the setting of reduced renal clearance or inflamed meninges. The agents are generally well tolerated; overall adverse events after injection range from 0.07–2.4%. True allergic reactions are rare (0.004–0.7%) but have been reported. Severe life-threatening reactions are exceedingly rare; in one report, only 55 reactions out of 20 million doses occurred. However, the adverse reaction rate in patients with a prior history of reaction to gadolinium is eight times higher than normal. Other risk factors include atopy or asthma (3.7%); although there is no cross-reactivity to iodinated contrast material, those with a prior allergic response to iodine should be considered at higher risk. Gadolinium contrast material can be administered safely to children as well as adults, although these agents are generally avoided in those under 6 months of age.

NEPHROTOXICITY Contrast-induced renal failure does not occur with gadolinium agents. A rare complication, nephrogenic systemic fibrosis (NSF), has occurred in patients with severe renal insufficiency who have been exposed to gadolinium contrast agents. The onset of NSF has been reported between 5 and 75 days following exposure; histologic features include thickened collagen bundles with surrounding clefts, mucin deposition, and increased numbers of fibrocytes and elastic fibers in skin. In addition to dermatologic symptoms, other manifestations include widespread fibrosis of the skeletal muscle, bone, lungs, pleura, pericardium, myocardium, kidney, muscle, bone, testes, and dura. The American College of Radiology recommends that a glomerular filtration rate (GFR) assessment be obtained within 6 weeks prior to elective gadolinium-based MR contrast agent administration in patients with:

1. A history of renal disease (including solitary kidney, renal transplant, renal tumor)
2. Age >60 years
3. History of hypertension
4. History of diabetes
5. History of severe hepatic disease, liver transplant, or pending liver transplant; for these patients, it is recommended that the patient's GFR assessment be nearly contemporaneous with the MR examination

The incidence of NSF in patients with severe renal dysfunction (GFR <30) varies from 0.19 to 4%. Other risk factors for NSF include acute kidney injury, the use of nonmacrocyclic agents, and repeated or high-dose exposure to gadolinium. The American College of Radiology Committee on Drugs and Contrast Media states that patients receiving any gadolinium-containing agent should be considered at risk of NSF if they are on dialysis (of any form); have severe or end-stage chronic renal disease (eGFR <30 mL/min/1.73 m^2) without dialysis; eGFR of 30–40 mL/min/1.73 m^2 without dialysis (as the GFR may fluctuate); or have acute renal insufficiency.

COMPLICATIONS AND CONTRAINDICATIONS

From the patient's perspective, an MRI examination can be intimidating, and a higher level of cooperation is required than with CT. The patient lies on a table that is moved into a long, narrow gap within the magnet. Approximately 5% of the population experiences severe claustrophobia in the MR environment. This can be reduced by mild sedation but remains a problem for some. Because it takes between 3 and