improvements in outcomes of critically ill patients in whom pulmonary artery catheterization was performed. Improvements in noninvasive imaging techniques have made the pulmonary artery catheter much less important in diagnosing cardiac conditions, such as pericardial tamponade, constrictive pericarditis, right ventricular infarction, and ventricular septal defect.

Magnetic Resonance Imaging

Magnetic resonance angiography or imaging (MRI) is a noninvasive method that is increasingly used for studying the heart and vasculature, especially in patients who have contraindications to standard contrast angiography. MRI offers high-resolution dynamic and static images of the heart that can be obtained in any plane. Good-quality images can be obtained in a higher number of subjects than is typically possible with echocardiography. Obesity, claustrophobia, inability to perform multiple breath-holds of 10 to 20 seconds, and arrhythmias are causes of reduced image quality. The presence of cardiac pacemakers or implantable defibrillators is considered a contraindication for MRI. Magnetic resonance angiography is useful in the evaluation of cerebral, renovascular, and lower extremity arterial disease.

MRI offers significant advantages over other imaging techniques for the characterization of tissues (e.g., muscle, fat, scar). MRI is useful in the evaluation of ischemic heart disease because stress-rest myocardial perfusion (Fig. 4-17A) and areas of prior infarction (see Fig. 4-17B to D) can be visualized with excellent special resolution. Delayed gadolinium contrast enhancement in the myocardium is characteristic of scar or permanently damaged tissue (Video 4-6). The greater the transmural extent of delayed enhancement in a given segment, the lower is the likelihood of improved function in that segment after revascularization. Because of the better spatial resolution, delayed enhancement imaging can depict localized or subendocardial scars that are not detectable with nuclear imaging techniques. The combined use of stress-rest perfusion and delayed enhancement imaging has performance characteristics for diagnosing CAD that are as good as and probably superior to those of conventional stress tests using nuclear scintigraphy or echocardiography.

MRI is excellent for evaluating a variety of cardiomyopathies (Fig. 4-18). In addition to morphology and function, characteristic patterns of delayed enhancement have been reported in myocarditis, hypertrophic cardiomyopathy, and cardiac amyloidosis. MRI has also been used to help assess right ventricular morphology and function in patients with suspected arrhythmogenic right ventricular cardiomyopathy.

Computed Tomography of the Heart

Newer applications of computed tomography (CT) have greatly advanced our ability to diagnose cardiovascular disease

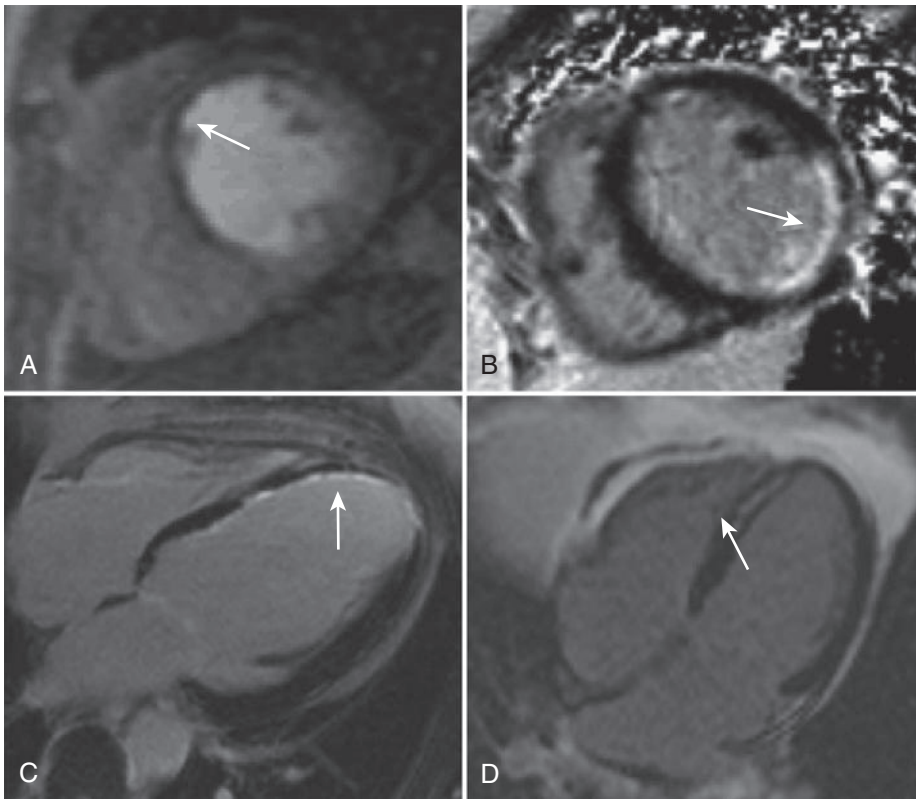

FIGURE 4-17 Use of cardiac magnetic resonance imaging in the evaluation of chest pain or ischemic heart disease. **A,** First-pass perfusion study during vasodilator stress shows a large septal perfusion defect *(arrow)*. The hypoperfused area appears dark compared with the myocardium with normal perfusion. **B,** Example of delayed enhancement imaging of an almost transmural infarction of the mid-inferolateral wall, including the posterior papillary muscle. Infarcted myocardium appears *white*, whereas normal myocardium is *black (arrow)*. **C,** Nontransmural (subendocardial) infarction of the septum and apex *(arrow)*. **D,** Patient with acute myocarditis mimicking an acute coronary syndrome. Mid-myocardial, rather than subendocardial, delayed enhancement is characteristic of myocarditis *(arrow)*.