ETT may help distinguish cardiac from noncardiac chest pain, exercise ECG has a number of limitations following myocardial infarction and revascularization (especially coronary artery bypass grafting). These patients frequently have rest ECG abnormalities. In addition, there is a clinical need to document both the magnitude and localization of ischemia to be able to direct therapy, especially the potential need for targeted revascularization. Consequently, imaging tests are preferred for evaluating patients with known CAD.

There are also important differences in the effectiveness of imaging tests in these patients. As discussed above, coronary CTA is limited in patients with prior revascularization. Patients with prior coronary artery bypass grafting are a particularly heterogeneous group with respect to the anatomic basis of ischemia and its implications for subsequent morbidity and mortality. In addition to graft attrition, progression of disease in the native coronary arteries is not uncommon in symptomatic patients. While CTA provides excellent visualization of the bypass grafts, the native circulation tends to get heavily calcified and is generally not a good target for imaging with CTA. Likewise, blooming artifacts from metallic stents also limit the application of coronary CTA in patients with prior percutaneous coronary intervention. Although newer stent material may change the potential role of CTA in the future, it is probably not the first line of testing in these patients. If an anatomic strategy is indicated, direct referral to invasive angiography is preferred.

Stress imaging approaches are especially useful and preferred in symptomatic patients with established CAD. As in patients without prior CAD, normal imaging studies in symptomatic patients with established CAD also identify a low-risk cohort. In those with abnormal stress imaging studies, the degree of abnormality relates to posttest risk. In addition, stress imaging approaches can localize and quantify the magnitude of ischemia (especially with perfusion imaging), thereby assisting in planning targeted revascularization procedures. As in patients without prior CAD, the choice of stress imaging strategy depends on availability and local expertise.

**Testing Strategy Considerations in Patients Presenting with Chest Pain to the Emergency Department** Although acute chest pain is a frequent reason for patient visits to the emergency department (ED), only a small minority of those presentations represent an acute coronary syndrome (ACS). Strategies used in the evaluation of these patients include novel cardiac biomarkers (e.g., serum troponins), conventional stress testing (ETT), and noninvasive cardiac imaging. It is generally accepted that the primary goal of this evaluation is exclusion of ACS and other serious conditions rather than detection of CAD.

The routine evaluation of acute chest pain in most centers in the United States includes admission to a chest pain unit to rule out ACS with the use of serial ECGs and cardiac biomarkers. In selected patients, stress testing with or without imaging may be used for further risk stratification. Stress echocardiography and radionuclide imaging are among the most frequently used imaging approaches in these patients. The relative strengths and weaknesses of these testing options have been discussed above. Both approaches have been shown to be effective for identifying low-risk patients who can be safely discharged from the ED. Multiparametric CMR imaging has also been used successfully in patients with acute chest pain. In addition to the combined assessment of regional and global left ventricular function, myocardial perfusion, and tissue viability, it is also possible to evaluate the presence of myocardial edema to characterize the myocardium at risk secondary to reduced coronary flow (Video 270e-5). Due to its ability to probe multiple aspects of myocardial physiology, cardiac anatomy, and tissue characterization with LGE imaging, CMR is also useful in diagnosing conditions that mimic ACS (e.g., acute myocarditis, takotsubo cardiomyopathy, pericarditis) (Fig. 270e-17). Thus, CMR imaging offers unique information of myocardial pathophysiology in the spectrum of ACS and is, perhaps, the most versatile of all noninvasive imaging techniques. Unfortunately, it is not widely available even at specialized centers and is not a first-line testing strategy. The main disadvantages of the "functional" testing strategy are that it is time consuming and is generally associated with a prolonged length of stay and, thus, is more costly.

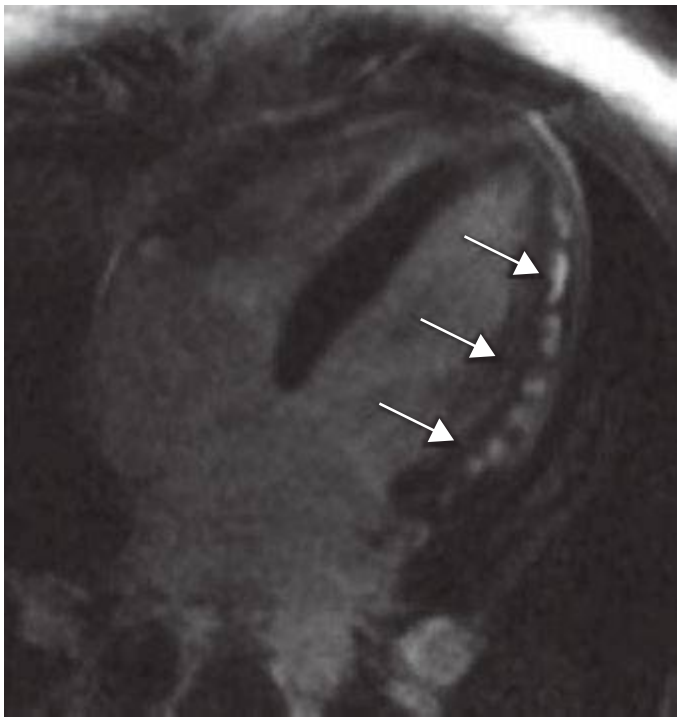

**FIGURE 270e-17 A four-chamber long-axis late gadolinium enhancement (LGE) image of a patient with acute myocarditis.** Note that the LGE primarily involved the epicardial aspect of the myocardium (*arrows*), sparing the endocardium, which is a feature that distinguishes myocarditis from myocardial infarction, which affects the endocardium. Also note the multiple foci of LGE in this case affecting the lateral wall of the left ventricle. Viral myocarditis often presents with this pattern.

As discussed above, coronary CTA is a rapid and accurate imaging technique to exclude the presence of CAD and is well suited for the evaluation of patients with acute chest pain (Fig. 270e-18). Several single-center and, more recently, multicenter studies have demonstrated the feasibility, safety, and accuracy of coronary CTA in the ED. There have been four randomized controlled trials evaluating the efficacy of coronary CTA as the initial testing strategy as compared to usual care (which typically includes stress imaging). Patients in these trials had a very low clinical risk. Overall, there were no deaths and very few myocardial infarctions without differences between the groups. Likewise, there were no differences in postdischarge ED visits or rehospitalizations. These studies showed decreased length of stay with coronary CTA, and most but not all reported cost savings. An observation from a recent meta-analysis was that, compared to usual care, more patients assigned to coronary CTA underwent cardiac catheterization (6.3% vs 8.4%, respectively) and revascularization (2.6% vs 4.6%, respectively). The relative increased frequency in the referral to cardiac catheterization and revascularization after coronary CTA compared to stress imaging testing strategies has also been observed in patients with stable chest pain syndromes.

Taken together, the available data clearly suggest that not all patients presenting with acute chest pain require specialized imaging testing. Patients with very low clinical risk and negative biomarkers (especially high-sensitivity troponin assays) can be safely triaged. The use of imaging tests in patients with low-intermediate risk should be carefully considered, especially given the trade-offs discussed above.

## VALVULAR HEART DISEASE

Abnormalities of any of the four valvular structures in the heart can lead to significant cardiac dysfunction, heart failure, or even death. Echocardiography, CMR, and cardiac CT can be used for the evaluation of valvular heart disease, although echocardiography has generally been considered the first imaging test of choice for the assessment of valvular heart disease. In addition, echocardiography is the most cost-effective screening method for valvular heart disease. In some cases,