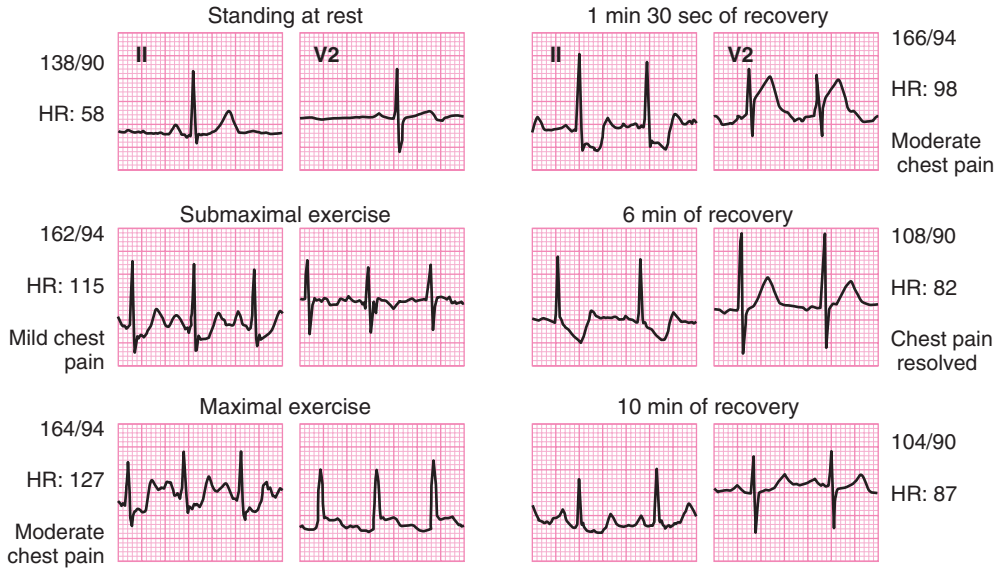

FIGURE 8-3 Treadmill exercise test demonstrates a markedly ischemic electrocardiogram (ECG) response. The resting ECG is normal. The test was stopped when the patient developed angina at a relatively low workload, accompanied by ST-segment depression in lead II and ST-segment elevation in lead V_2. These changes worsened early in recovery and resolved after administration of sublingual nitroglycerin. Only leads II and V_2 are shown; however, ischemic changes were seen in 10 of the 12 recorded leads. Severe atherosclerotic disease of all three coronary arteries was documented at subsequent cardiac catheterization.

radionuclide study. This imaging technique does not provide the anatomic detail associated with echocardiography, and it has the negative feature of significant radiation exposure.

An emerging imaging technique for stress testing is the use of magnetic resonance imaging. Radiation is not a concern, and cardiac structural imaging can match echocardiography (or exceed it in patients with poor images on echocardiography). The technique is not as easy to execute as echocardiography, but magnetic resonance imaging is likely to gain favor in exercise testing.

Not all patients who require noninvasive testing for CAD are able to exercise to a degree sufficient to induce ischemia, and for some patients exercise testing is not an option at all. For these patients, pharmacologic stress testing has evolved as a viable alternative to exercise testing. The prognostic benefit of exercise workload is not available from this form of testing, but information regarding the presence of ischemia-inducing atherosclerosis is obtainable. One common form of pharmacologic testing relies on inducing coronary vasodilation (as with dipyridamole, adenosine, or regadenosine), which produces a disparity of myocardial blood flow based on the presence of coronary stenosis. Radionuclide administered during the infusion of the coronary vasodilator allows for detection of myocardial ischemia similar to that observed with exercise testing. An alternative pharmacologic approach uses the inotropic and chronotropic effects of dobutamine to increase myocardial oxygen demand and induce segmental ischemia. Echocardiography is commonly used to detect dobutamine-induced wall motion abnormalities with this approach, although radionuclide or magnetic resonance imaging could also be used.

All of the stress testing techniques discussed here are able to assess for the presence of inducible myocardial ischemia associated with CAD. The presence of CAD can also be determined by assessment of coronary calcification using either EBCT or the now more common MDCT. Coronary calcification is present only because of underlying CAD. Although detecting its presence does not directly indicate the presence of obstructive CAD as would an abnormal imaging stress test, studies have shown a direct correlation between the amount of coronary calcification and the probability that a 70% stenosis is present. At the least, this type of information informs the physician that CAD is present and directs aggressive attention toward risk factor modification. MDCT scanners can reliably perform coronary angiography with the use of intravenous contrast agents and specifically timed imaging protocols. This technique is becoming increasingly used to detect the presence of obstructive CAD, although it cannot precisely define the severity of stenosis. MDCT is also valuable in defining coronary anomalies, and a negative study carries a high negative predictive value for the occurrence of coronary events.

Invasive coronary angiography has been considered the "gold standard" for detecting the extent and severity of underlying CAD. This approach carries a small risk of MI, stroke, or death, so it must not be taken lightly. In the case of patients with positive stress tests, particularly those with high-risk features, coronary angiography adds more discrete information regarding the underlying disease and guides the potential use of revascularization techniques (i.e., percutaneous coronary intervention or coronary artery bypass surgery) versus medical therapy to treat CAD (Table 8-3). Additional tools, such as pressure wires used to perform fractional flow reserve studies (FFR), add to the diagnostic power of invasive catheterization by allowing one to discriminate between physiologically significant lesions and those not likely to cause ischemia. Revascularization is not indicated for lesions that do not cause ischemia.

The physician must also be cognizant of the fact that not all chest discomfort is related to CAD. Although CAD as a cause of chest discomfort poses the biggest risk for poor outcomes, other