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Editorial Comment

Exercise Echocardiography: Coming of Age*

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Background. Coronary artery disease is the leading cause of adult death in the United States. A reliable, cost-effective method for detecting the presence of this disorder is central to efforts intended to reduce coronary morbidity and mortality in afflicted patients. Although a typical angina syndrome may signal patients to seek medical attention, as many as half of those who present with acute myocardial infarction or sudden cardiac death have no recognized antecedent warning symptoms. Moreover, even in patients who experience angina, the majority of myocardial ischemic episodes are clinically silent. Subjective historical information proffered by the patient is therefore not sufficient for assessing the status of the myocardial blood supply. Although the consequences of coronary stenosis may be manifest under rest conditions (e.g., unstable angina), coronary insufficiency is generally identified by testing that is designed to detect the consequences of *provoked* myocardial ischemia. The most widely available and performed provocative test to detect the presence of coronary artery disease is the exercise electrocardiogram (ECG). Although this test can be performed, interpreted and reported quickly and at low cost, it has limited sensitivity and specificity, and its predictive value, which is only fair in ideally suited patients, is inadequate in many patient populations. Such groups include patients with the following characteristics: left bundle branch block; nonfasting state; previous myocardial infarction; previous coronary bypass surgery or angioplasty; drug therapy that can affect the rest or exercise ECG (e.g., digoxin and antiarrhythmic, diuretic and antidepressant agents); rest repolarization abnormalities; inability to exercise; valvular heart disease, including mitral valve prolapse; and female gender (1).

Segmental myocardial contractile failure is one of the earliest detectable consequences of myocardial ischemia, developing within seconds of coronary occlusion (2). The ability of echocardiography to depict regional wall motion led investigators to explore the use of this imaging modality in conjunction with stress testing (3). Exercise echocardiography subsequently evolved into a highly sensitive and specific modality for detecting the presence, extent and regional vascular distribution of coronary artery disease in a variety of patient groups, including those being screened for an initial diagnosis or preoperative clearance, those who have undergone surgical or percutaneous revascularization and those who have sustained a previous myocardial infarction, in whom this test also assists in risk stratification (4–9).

Present study. In this issue of the Journal, Roger et al. (10) add to a growing body of published reports supporting the clinical application of exercise echocardiography. In line with the findings of other investigators (3–5,11), the overall sensitivity for the presence of coronary artery disease was 91%. The important new finding was that the sensitivity of this technique for detecting *multivessel* disease, indicated by provoked contractile failure in multiple vascular distributions, was 73%, and the specificity was 70%, defining "significant" coronary artery stenosis as ≥50% lumen narrowing. When significant stenosis was defined as ≥70%, the sensitivity increased to 83%, whereas the specificity decreased to 62%. Roger et al. went on to demonstrate that when coupled with historical or ECG evidence of previous myocardial infarction or with the development of at least 2 mm of flat or downsloping ST segment depression, the exercise echocardiogram carried a high predictive value for the presence of multivessel coronary artery disease. It is important, however, to place their findings in context. A priori, most patients with coronary artery disease have multivessel involvement. As a case in point, in the study population of Roger et al., there were 39 patients with a history of previous myocardial infarction. Thirty-four (87%) of these patients had multivessel disease, making such a history the most powerful single predictor of this extent of disease. Nevertheless, when combined with the results of the treadmill ECG and historical information, exercise echocardiography added importantly to the ability to predict the presence of multivessel disease. Roger et al. suggest that such information is helpful in identifying which patients should be referred for coronary arteriography and possible revascularization.

Discussion. The risk of cardiac morbidity and mortality in patients with coronary artery disease has been shown to be dependent on its clinical behavior (e.g., stable vs. unstable), the extent of disease (i.e., the amount of myocardium at risk) and left ventricular function. In addition to its ability to detect provoked regional wall motion abnormalities, and thereby to predict the presence, absence, extent and distribution of coronary artery disease, stress echocardiography can be used to assess left ventricular size and ejection fraction. Consequences of previous myocardial infarction, such as thrombus or aneurysm formation, can be detected. In addition, cardiac ultrasound can detect noncoronary causes of chest pain, including valvular heart disease, occult

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congenital heart disease (e.g., atrial septal defect), cardiomyopathy, cardiac tumors and pericardial disease, and the pulmonary artery pressure can be estimated. Such a comprehensive assessment of the state of the coronary vasculature and of cardiac anatomy, physiology and risk cannot be obtained with any other noninvasive methodology. As experience with performance and interpretation grows, and as methods develop to overcome imaging difficulties in some patients (e.g., improved echocardiographic apparatus, use of ultrasound contrast agents), exercise echocardiography will continue to evolve into a uniquely informative noninvasive technique that can be applied to a variety of patient groups, in many of which routine stress testing has serious limitations.

We believe that exercise echocardiography has matured into a test of great clinical usefulness in evaluating patients with known or suspected coronary artery disease. At a time when the cost-effectiveness of newer techniques and technologies is becoming increasingly scrutinized, when "gatekeepers" will be incentivized to "control" costs by limiting access and when physicians and patients face increasing restrictions on clinical decision making, one can expect that the broad use of exercise echocardiography might be called into question. We believe that a more appropriate question might be, Is the widespread performance of, and reimbursement for, standard exercise electrocardiography in patients being evaluated for coronary artery disease justifiable?

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