
Evaluation of patients for coronary artery bypass surgery: The role of exercise testing

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The indications for coronary artery bypass graft (CABG) surgery in asymptomatic and mildly symptomatic patients have undergone continuing change as the result of large multicenter randomized trials.¹⁻⁴ The parameters most commonly used for stratifying patients with respect to potential benefit from CABG are the extent of coronary artery disease and the degree of left ventricular dysfunction present. Although the exercise test has been shown to provide useful information for assessing prognosis in patients with coronary disease,⁵⁻⁷ exercise testing has not been consistently used in conjunction with angiography for determining whether patients with coronary disease should have medical or surgical therapy. The purpose of this communication is to evaluate whether the results from exercise testing are useful for determining a patient's potential benefit from CABG surgery.

Exercise testing to determine the physiologic effect of stenosis. Severity of coronary arterial obstruction is most commonly based upon visual estimate of percent stenosis, a technique that has been shown to have a large degree of intraobserver variability in describing lesion severity.^{8,9} In addition, the coronary arteriogram may either overestimate or underestimate the true degree of stenosis.^{10,11} Quantitative angiography addresses these problems,¹² but still does not reflect the physiologic significance of coronary artery stenosis.¹³ The exercise test provides an indirect measure of coronary flow reserve, and gives a better idea of the degree of myocardium at jeopardy and the functional status of collaterals than can be derived from angiography. The functional data from the exercise test are complementary to the anatomic information derived from the angiogram. Exercise

testing may be particularly important in cases where there is a question as to the significance of a coronary artery stenosis. In addition, the exercise test gives a quantitative measure of functional capacity prior to surgery.

Exercise testing to identify patients most likely to benefit from surgery. The exercise test, when performed as part of a screening examination or as part of a diagnostic evaluation of chest pain, may be the initial indicator of severe coronary artery disease. Findings that have been shown to reflect a significant degree of ischemic myocardium include exertional hypotension, final exercise stage, increased pulmonary uptake of thallium, and multiple areas of reversible thallium defects.^{5-7,14-24} Patients with these findings may benefit from interventional therapy, and should be considered for further evaluation with cardiac catheterization to determine the anatomic extent of coronary artery disease.

In addition to diagnosis of significant coronary artery disease, exercise testing has been shown to be useful for assessing prognosis,^{5-7,25-30} and can be used to stratify risk from among a group with an "equivalent" degree of coronary artery disease.³¹⁻³⁵ Weiner et al.³⁴ found that the duration of exercise attained was an independent predictor of survival in a group of patients with three-vessel coronary disease and preserved left ventricular function. Kent et al.³² also showed that exercise capacity was an important determinant of mortality among asymptomatic or mildly symptomatic patients with triple-vessel disease. In a study of mildly symptomatic patients with three-vessel disease and normal left ventricular function, Bonow et al.³⁵ showed that patients without signs of exercise-related myocardial ischemia had no mortality over 4-year follow up; patients with electrocardiographic signs of ischemia during exercise, an exercise-related fall in ejection, and reduced exercise tolerance had a 4-year survival of 71%.

Exercise test results can also be used to stratify patients with respect to potential for benefiting from CABG. The European Coronary Surgery Study³⁶

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showed better survival for surgical therapy (compared with medical therapy) in patients with two- or three-vessel disease and a positive stress test; there was no increased benefit from CABG in patients with less than 1 mm ST depression. Results from the CASS registry³⁷ also indicate an important role of exercise testing when used in conjunction with angiographic data, particularly for patients with three-vessel disease.³⁸ Patients with three-vessel coronary disease and normal left ventricular function who had an early positive test were found to benefit from surgery, while survival was not different in medical and surgical groups in patients with triple-vessel disease who did not have ST depression or who had good exercise capacity. Similar results were found for patients with three-vessel disease and left ventricular dysfunction; no improvement with surgery was seen in the group with good exercise tolerance.³⁷ Thus the improved survival demonstrated for patients with triple-vessel disease and reduced ejection fraction who have CABG³⁹ may be concentrated primarily in patients with abnormal exercise tests. Further work needs to be done to verify these findings, but the study raises the possibility that groups now identified as benefiting from CABG can be further stratified by use of exercise testing.

Limitations of the exercise test. All patients being considered for CABG are not candidates for exercise testing, particularly those with unstable symptoms or patients with an angiographic assessment that precludes further evaluation (i.e., significant left main coronary artery disease). In addition, some patients are unable to exercise secondary to vascular disease or because of concomitant medical problems. The results of the exercise test may be affected by the use of cardiac medications⁴⁰ or by failure to achieve adequate stress. This demands individual assessment. Of note, most studies of the prognostic importance of exercise testing have included patients taking medications.

Conclusions. The exercise test has two potential roles in the process for determining whether patients will benefit from CABG, (1) as an adjunct to angiography to assess the physiologic effect of stenosis and (2) for stratification to determine the likelihood of improved survival with CABG as compared with medical therapy. The exercise test results also provide a baseline with which to compare the post-surgical condition.

As a functional test, the exercise test complements angiography. Exercise results reflect the physiologic significance of stenosis and left ventricular dysfunction, and have been shown to have prognostic importance. The test is a useful measure of myocardium at

jeopardy, and thus addresses some of the problems resulting from characterizing coronary disease according to the number of blood vessels involved and the error resulting from visual assessment of stenosis. Use of exercise data in conjunction with angiographic information may facilitate identifying a high-risk subgroup from among patients with similar left ventricular function and anatomic severity of disease who will benefit from surgery and identifying another group with good functional capacity and no signs of ischemia who may benefit from continued medical therapy.

The recently released report from the ACC/AHA task force on Coronary Artery Bypass Graft Surgery⁴ states that "coronary artery bypass operation is indicated only uncommonly for asymptomatic patients with no or mild myocardial ischemia with non-invasive stress testing."⁴ Unless there is a compelling reason to perform surgery (e.g., left main disease) or a contraindication to exercise, the preoperative assessment of patients with mildly symptomatic coronary disease should include a functional test such as exercise testing. The results can then be integrated with the angiographic data to provide the basis for decision making.

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