Exercise testing: electrocardiography and radionuclide cineangiography

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Although coronary artery stenosis detected by coronary arteriography can define regions of potential ischemia, assessment of the presence of ischemia requires testing of cardiac function. However, in patients with stable coronary artery disease, ischemia seldom is present with the patient at rest. Therefore, in such patients, accurate assessment of the presence and extent of ischemic heart disease requires evaluation during stress, such as that imposed by exercise.

Electrocardiography during exercise provides one method for such assessment. However, comparison of the exercise ECG with coronary arteriographic studies performed at many large medical centers indicates that the exercise ECG is relatively insensitive (sensitivity 50% to 80%) in identifying symptomatic patients with large vessel coronary artery disease.[1] Moreover, our study of 30 asymptomatic subjects with positive exercise ECGs revealed that only 39% of these patients had angiographically demonstrable coronary artery stenoses of $\geq$ 50% of the coronary lumen. Thirty percent had no coronary abnormalities and 30% had minor wall irregularities. These findings are indistinguishable from those of Froehlicher et al[2], who have performed the only other published assessment

of asymptomatic subjects with positive exercise ECGs.

Clearly, therefore, although the exercise ECG is valuable in epidemiologic studies and, when combined with other tests, may be a valuable adjunct in determining prognosis, it is not by itself sufficiently accurate to be used as an indicator either of the presence or of the severity of coronary artery disease.

Because of these considerations, we have developed a noninvasive real-time radionuclide cineangiographic procedure permitting cutaneous monitoring and analysis of left ventricular function during intense exercise.[3] Using standard nuclear medicine equipment, radioactive emissions from the cardiac blood pool can be localized as to their site and origin, and immediately displayed as a series of pictures of the heart. The resulting movie spans the entire cardiac cycle. Since at equilibrium the amount of radioactivity measured in any region must be proportional to the amount of blood in that region, by determining the number of radioactive emissions within the left ventricle in each picture of the movie (a simple computer procedure), it is possible to determine the ejection fraction of the left ventricle.

We have studied more than 600 patients with this technique, and more than 100 have had coronary artery disease or chest pain suggestive of coronary artery disease.[4] In 97% of patients with coronary artery disease, we have discerned wall motion abnormalities during exercise diagnostic of the presence of ischemic heart disease. In the same group, only 55% had positive exercise ECGs. No patient without coronary artery disease has manifested regional abnormality on radionuclide cineangiography. Moreover, while in our 35 normal subjects, and in all those with chest pain without coronary artery disease, ejection fraction has risen during exercise (average rise 25%), global ejection fraction almost invariably has fallen during exercise to levels well below the normal range (average fall 25%). Thus, radionuclide cineangiography during exercise permits accurate assessment of the presence and functional severity of ischemic heart disease. Moreover, the technique is well suited to evaluation of the efficacy of therapy. During exercise we have been able to demonstrate the beneficial effects of nitroglycerin and of coronary artery bypass grafting and have assessed the effects of propranolol in these patients. We believe radionuclide cineangiography during exercise represents an important new tool in the evaluation of patients with coronary artery disease.

References

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