COMMENTARY

Thallium-201—When Should We Use It?

> I took some sheets of paper and, rolling them very tightly, I applied one end to the precordial region and placing my ear at the other end, I was as surprised as I was gratified to hear the beating of the heart much more clearly and distinctly than if I had applied my ear directly to the chest. It occurred to me that this means could become a useful method .....
>
> R.-T.-H. Laennec (*1*)

The introduction of Laennec's paper stethoscope revolutionized the practice of medicine. The technological revolution of the twentieth century has brought with it another fundamental change. This new medicine is the child of the technological revolution, and its contribution to diagnosis has paralleled the growth of technology.

Unlike Laennec's sheets of paper, the new medicine has not come cheaply, and unlike the occasional breakthroughs of the nineteenth century, the new medicine introduces diagnostic tests faster than they can be digested into the standard diagnostic process. As a response, our ability to evaluate these new diagnostic tests has rapidly evolved into a scientific discipline all of its own.

Hamilton (*2*), in this issue of the *Journal,* has applied these principles to myocardial scintigraphy with thallium-201. The possiblity of using radiotracers to detect regions of reduced perfusion was first demonstrated by Yates in 1952 using phosphorus-32 (*3*). The possibility of measuring blood flow using radiopotassium was first proposed by Sapirstein with his enunciation of the indicator fractionation principle (*4*), and subsequent investigators exploited scintigraphic imaging with potassium analogs as a means to map regional myocardial perfusion (*5*). The demonstration that transiently ischemic myocardium could be detected and evaluated by imaging after exercise greatly expanded the potential of the method (*6*). The introduction of thallium-201 has provided diagnostic nuclear medicine with a commercially available tracer that if not ideal, does permit routine myocardial imaging after exercise and several hours later when redistribution of the tracer has occurred (*7*). The most recent refinement of the technique, tomographic myocardial scintigraphy, promises to further increase the sensitivity for the detection of coronary artery disease and, we hope, the overall accuracy as well (*8,9*).

Hamilton has carefully examined the accuracy of myocardial imaging with thallium-201, a major factor in determining its usefulness in the management of coronary artery disease. This information should be read and reread by the physicians who perform the test as well as those who order it. As Hamilton suggests, the conditions that determine the usefulness of a diagnostic test are not only its specificity and sensitivity, but also the medical milieu in which it is performed. Thus, the test's true value depends on the effect it will have on the patient's treatment, on his longevity, and on the subsequent quality of his life—factors that are usually controversial, virtually impossible to quantitate, and continually changing. We will, nevertheless, explore at least several factors in the management of coronary artery disease that contribute significantly to the impact of myocardial scintigraphy with thallium-201.

Can myocardial perfusion scintigraphy be used to help select those patients who are candidates for coronary revascularization surgery? Unfortunately, the indications for coronary bypass surgery are among the most controversial topics in medicine today (*10,11*). There is a great polarization of views—some advocate surgery in almost any patient with coronary artery stenosis, but others will only permit surgery as a last resort. Nevertheless, from the evidence available to us today, there are two clear indications for bypass surgery (*10*): (1) symptomatic patients with stenosis of the left main coronary artery and (2) severely symptomatic patients with lesions anywhere in the coronary system, whose anginal pain is uncontrolled by optimal medical management. Surgery is indicated in left main coronary artery disease because it prolongs life. Myocardial perfusion scin-

tigraphy would be of immense value were it able to distinguish those patients with left main coronary artery disease from those with other coronary artery disease. Unfortunately, the evidence indicates that myocardial perfusion scintigraphy cannot make that distinction (*13,14*).

There is suggestive evidence that a third indication for surgery may be exertional left-ventricular dysfunction. Despite medical therapy, patients with these symptoms may have a high risk of infarction and death (*15*). If the initial results are confirmed, a direct index of ventricular performance, such as the radionuclide ventriculogram would be preferred as a diagnostic procedure for initial screening rather than myocardial scintigraphy with thallium-201. For myocardial scintigraphy to be useful, it will require improvement in our interpretative and technical abilities. There have already been several promising recent developments. Dash et al. have described two scintigraphic patterns that appear characteristic for left main and three-vessel coronary artery disease (*16*). The sensitivity of this pattern for isolating left main and three-vessel disease appears low, but if these patterns accurately delineate those patients at particularly high risk, then perfusion scintigraphy might achieve added stature in the identification of surgical candidates. The use of longitudinal or transaxial tomography is an alternative track, which provides substantially improved technical detail and may enable us to improve our diagnostic criteria (*8,9*). In any case, with the available evidence, myocardial scintigraphy should play only a limited role in the identification of candidates for revascularization surgery.

It might be argued that the role of perfusion scintigraphy is precisely the reverse—the identification of patients clearly not suited to revascularization surgery because of extensive infarcted myocardium. Many feel that left ventricular dysfunction per se, however, is not a contraindication to bypass surgery. Although patients with significant left-ventricular dysfunction have somewhat higher surgical risk, it is felt that these patients with unacceptably severe symptoms of myocardial ischemia should not be denied surgery because of left-ventricular dysfunction (*17*). Furthermore, the radionuclide ventriculogram is better suited for evaluating left-ventricular function and is the preferred technique in this setting (*18,19*).

Should myocardial scintigraphy with thallium-201 be used in the assessment of asymptomatic patients at high risk? As Hamilton notes, one would expect thallium scintigraphy to be less useful as a screening test in these patients because the prevalence of coronary artery disease in this population is low. Furthermore, the clinical dilemma of what to do with asymptomatic individuals who have an abnormal thallium stress test has not been solved. At the present time, there are no reliable data to suggest that a particular medical or surgical management will significantly affect morbidity and mortality in an asymptomatic coronary artery disease population (*20*). In fact, it may be counterproductive to label them as coronary artery disease patients from both a legal and psychological point of view. On the other hand, if a stress test demonstrates asymptomatic ST-depression, a normal stress myocardial scintigram provides reassurance and prevents unnecessary labeling of individuals as coronary artery disease patients.

The major current clinical indication for thallium imaging is for the evaluation of patients with atypical chest pain. Even here, however, the use of myocardial scintigraphy cannot replace clinical judgment and should be reserved only for those patients with a moderate likelihood of coronary artery disease. Atypical angina represents a broad spectrum of presentations. Furthermore, other standard tests, such as the ECG stress test, should be fully exploited to classify these patients. For example, when criteria in addition to classical ST segment changes are applied (such as length of exercise, chest pain, and additional electrophysiologic data), the ECG stress test can frequently isolate the population subsets of low and high probability of coronary artery disease (*21,22*). It is in those patients in whom the stress test is equivocal or nondiagnostic that stress scintigraphy plays a major role. This group includes those with left bundle branch block or left ventricular hypertrophy, and those who receive digitalis preparations, and in whom evaluation of stress electrocardiographic changes is particularly difficult. Although this group is a minority of those seen clinically, they often present significant diagnostic and treatment problems. Many of these patients do not have demonstrable coronary artery disease and thus do not require cardiac medications; on the other hand, some do have significant obstructive cororary artery disease that requires pharmacologic or even surgical intervention.

The rapid developments in the field of myocardial imaging as well as advancements in our understanding of the pathophysiology of coronary artery disease and its management will undoubtedly require modifications of these concepts. It is crucial, therefore, that rigorous clinical studies

of myocardial scintigraphy continue. It is equally crucial that we use thallium imaging intelligently and apply it only in disease populations where the test is likely to provide meaningful clinical information and where that information is useful in clinical decision making.

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