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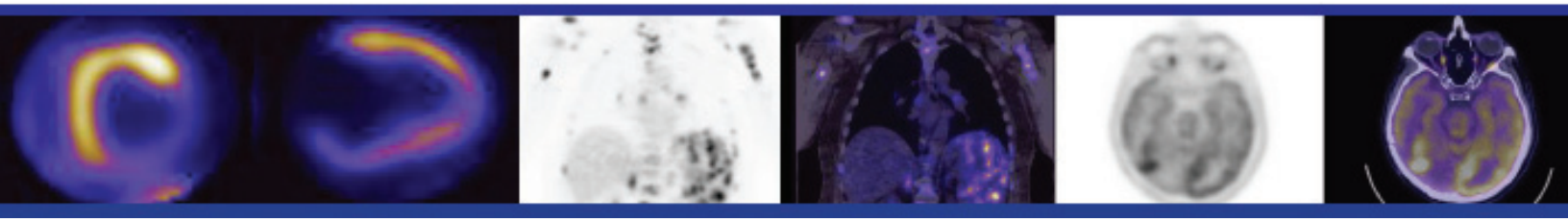

Radionuclide Perfusion Imaging of the Heart

About Heart Disease

Heart disease is the leading cause of death in the United States, killing more than half a million men and women each year. There are many different types of heart disease, but the most common is coronary artery disease—the leading cause of heart attacks. Fortunately, tremendous advances in recent years have greatly improved the way heart disease is detected and diagnosed—allowing physicians to more accurately treat heart disease at its most curable stage.

What are molecular imaging procedures that can help heart disease patients?

Radionuclide myocardial perfusion imaging is the most common nuclear medicine procedure to evaluate the heart. It is effective, safe and painless for evaluating coronary artery disease. The body of scientific literature documenting advances in this area is prolific and clearly shows its value for the evaluation of heart disease.

Radionuclide myocardial perfusion imaging is a powerful tool to:

- *Detect whether a patient has obstructive coronary artery disease.* Coronary artery disease is caused by the accumulation of plaques in the walls of the arteries (atherosclerosis) that supply blood to the myocardium (the muscle of the heart). These plaques create blockages (stenoses) in the coronary arteries and impair blood flow to the myocardium. Impaired blood flow to the heart muscle restricts its ability to function and pump blood to the body. Myocardial perfusion imaging is the most accurate test available for assessing the impact of these plaques on the blood flow to the heart in patients who may be at risk for a heart attack, including those with abnormal or inconclusive stress electrocardiographs.
- *Determine the extent and impact of a coronary stenosis.* The extent of abnormal perfusion to the myocardium will guide catheterization procedures and decision to perform revascularization—a procedure that restores blood flow to the heart by opening the blocked artery with a balloon or by surgically performing bypass grafting.
- *Evaluate prognosis and guide health care decisions.* The risk of developing heart disease increases as patients age, and in special groups of patients at risk—for example, in patients with diabetes. The extent of the myocardium that has reduced perfusion can help physicians and patients make effective decisions.
- *Monitor medical treatment for patients with coronary artery disease.*

When should myocardial perfusion imaging be prescribed?

When a patient has a family history of coronary artery disease or other symptoms suspicious for coronary artery disease, such as chest pain, a radionuclide myocardial perfusion imaging rest/stress test can help to detect the disease. It can help detect coronary disease before symptoms occur and give physicians information about how a patient's heart is functioning and the extent and severity of any abnormality related to blood flow in the heart muscle.

How is myocardial perfusion imaging performed?

A small amount of radioactive material such as thallium or technetium is injected into a patient's vein. The radioactive material travels to the patient's heart muscle and pictures are taken with a special camera to obtain a three-dimensional image. Often, coronary disease can only be diagnosed during stress, or when the heart rate is elevated. The study requires two sets of pictures of the heart and usually two sets of injections. One set of images is obtained immediately after a patient exercises on a treadmill or after stressing the heart with a medication, and the other is taken while the heart is at rest.

What types of technologies are used to perform this test?

Radionuclide myocardial perfusion imaging can be performed with single photon emission computed tomography (SPECT) or positron emission tomography (PET). SPECT uses a gamma camera to acquire multiple images which are used to create a three-dimensional dataset of the

heart. SPECT has been proven effective in detecting blockage in the coronary arteries that decrease myocardial perfusion at rest and during stress. As a result, SPECT is now widely used in nuclear cardiology laboratories across the country.

PET is similar to SPECT in its use of radioactive tracer material and detection of gamma rays. However, the tracer characteristics require a different type of scanner to detect the gamma rays. Attenuation—the inability to get a clear signal—from soft tissue in patients with larger body habitus or in women with large breasts, for example, is a common problem for the interpretation of SPECT studies. PET has higher spatial resolution and better capability to perform attenuation correction, resulting in higher accuracy in detecting coronary artery disease and damaged heart tissue. The use of PET in myocardial imaging is expected to increase in the near future as PET systems become more affordable and more widely available across the country.

In addition, hybrid imaging technologies that combine SPECT with computed tomography (CT) or PET and CT are now available. Studies show that the combined scans improve the specificity of the images and diagnostic accuracy. CT can show the plaque in the inner lining of the arteries that can cause narrowing and restrict the flow of blood to the heart muscle. SPECT or PET can show the consequence of the blockage of the artery on the blood flow to the heart. Arteries that rupture may cause sudden heart attack, stroke or death.

What are the radiation risks to patients from these tests?

Radionuclide myocardial perfusion imaging is a noninvasive test and carries no risk beyond that of exercising on the treadmill or the risk of the medication administered to stress the heart. The radioactive isotope injected for the study is non-allergenic and produces radiation exposure to the patient in the same range as CT scans. When myocardial perfusion imaging is considered for a patient, the risk of dying from heart disease is far greater than the radiation exposure risk. Patients who are pregnant or breastfeeding should inform their doctors before undergoing this test.

Can the results of myocardial perfusion imaging help determine a patient's risk for heart attacks or other complications?

Determining a patient's prognosis is an important function of myocardial perfusion tests. For example, only about 1 percent of patients with normal scans suffer subsequent events such as heart attacks or death from heart disease, even in patients who have been identified with coronary artery disease or who have had heart attacks in the past. In contrast, scans that reveal more extensive or severe abnormalities are highly correlated with the risk of subsequent heart attacks or deaths.

How can myocardial perfusion imaging help patients with stable angina?

Stable angina is characterized by chest pain or discomfort that typically occurs with activity or stress. The pain usually begins slowly and gets worse over the next few minutes before dissipating. It quickly subsides with medication or rest, but may occur again with additional activity or stress. The condition is caused by too little blood flow to the heart, most commonly because of coronary artery disease. While the ways that physicians evaluate and treat this condition vary widely, the major options include either performing a noninvasive diagnostic workup (including stress myocardial perfusion imaging and other tests such as ECGs) or moving directly to catheterization and revascularization procedures, including surgery. A large study of more than 11,000 stable angina patients showed that performing myocardial perfusion imaging before surgery was safer—resulting in fewer patient deaths and lower costs than moving directly to surgery.

Can myocardial perfusion imaging help patients who have already had a heart attack?

A heart attack—also called a myocardial infarct—occurs when the blood supply to part of the heart is interrupted. If a patient has previously suffered a heart attack and the location of the infarct is known, myocardial perfusion imaging can reveal whether there is a new defect in another location and whether new types of treatment or surgery are needed.

What about patients who are considering revascularization surgery after a heart attack?

Patients whose heart disease is advanced have a higher incidence of surgical complications and should not be subjected to the risk of revascularization surgery if the heart muscle is not viable. SPECT and PET can also assess whether the myocardium is viable. With PET, the most common tracer used for evaluation of viability is fluorodeoxyglucose (FDG), a radioactive sugar used by the myocardium when viable. If the myocardium is viable, revascularization in addition to medical therapy provide better outcome for patients.

Can myocardial perfusion imaging help determine whether heart disease is occurring in patients with diabetes?

Approximately 16 million people in the United States have diabetes, which is a major risk factor for coronary artery disease. Diabetics with coronary artery disease have higher death rates following acute heart attacks or revascularization surgery than non-diabetics with heart disease. Myocardial perfusion imaging in diabetic patients is essential to predict risk. Identifying diabetics with coronary artery disease is an important step in managing both diseases.

How can myocardial perfusion imaging help in detecting and diagnosing heart disease in women?

Heart disease is the leading cause of death among women, but it is often much more difficult to detect than in men. In women, interference of breast issue and breast implants in scanning and the inability to properly diagnose possible symptoms of heart attack make it harder to accurately diagnose heart disease. With SPECT, women show fewer true positive scans than men, and women's symptoms of a possible heart attack (which include nausea, vomiting, and jaw or back pain) are different than men's—and make diagnoses more difficult. However, studies show that combined PET/CT scans improve the specificity of the images and diagnostic accuracy in patients with large breasts or breast implants. PET/CT also may have the advantage in the diagnosis of smaller vessel disease (which is more common in women) and may be better at diagnosing disease in individuals with smaller hearts.

Will insurance reimburse for SPECT and PET/CT scans?

Insurance companies will cover the cost of most SPECT and/or PET for heart conditions. For the most updated information, check with your insurance carrier or physician.

What other new developments are on the horizon for diagnosing and treating heart disease with molecular imaging techologies?

Researchers are making exciting advances in understanding the molecular and genetic mechanisms of cardiovascular disease. New radioactive tracers are under investigation to look at the metabolism and nerve supply of the heart. New imaging techniques will be essential for developing biologically based approaches to diagnosing and treating heart disease. Promising areas of research include the development of novel reporter-gene imaging systems, which involves engineering genes that can adhere to cells and be tracked with molecular imaging technologies. In addition, scientists are working on ways to image molecular markers and biological pathways that provide insight as to how heart disease progresses and can help physicians assess whether other therapies are working as intended.

Where can I get more information about molecular imaging?

To learn more about PET/CT scanning and other nuclear medicine and molecular imaging procedures, visit the SNM Molecular Imaging Center of Excellence and SNM PET Center of Excellence.