Nuclear Cardiology

Background: Heart disease is the leading killer of Americans today, and heart attack is the most visible sign of heart disease. A heart attack occurs when the blood supply to the heart is restricted to the point that a portion of the heart muscle dies. This is usually brought on by blockages in the arteries feeding the heart, known as coronary atherosclerosis. Cardiologists use several different tests to discover whether a patient has significant coronary atherosclerosis, and to try to determine the patient's risk of developing a heart attack in the future. In addition, these tests can be used to assess muscle strength. One group of tests falls under the heading "Nuclear Cardiology". These are studies in which small doses of radioactive tracer substances are given to the patient. The tracers collect in the heart muscle or in the blood stream. Pictures of the heart are then obtained using a special device called an Anger Camera (named after its inventor).

What types of tests are there? There are two types of nuclear tests generally used in the evaluation of heart patients. The most common is the "perfusion study". This is a test where a radioactive isotope (usually thallium or technetium) is used in extremely small "tracer" quantities to show which parts of the heart are receiving an adequate blood supply when the patient is resting or exercising. Frequently these tests can also show the strength of the heart muscle. Some names for this type of test are thallium scan, dual isotope scan, Cardiolyte scan, and sestamibi scan. A second type of test is called a "blood pool study". In this test, the blood cells themselves are labeled with an extremely small amount of radioactive tracer. Pictures of the blood in the heart are then obtained with the nuclear camera. This type of test can produce very accurate and reproducible measurements of heart strength and size and are typically used when studies of heart strength over time are desired. This type of test is also referred to as a radionuclide ventriculogram or MUGA scan. Other types of tests are being developed for use in the future, or are being used for research or other specialized purposes.

Who should be tested? The most common indication for a nuclear cardiac imaging study is to determine if a patient has blockages of the blood vessels feeding the heart. The studies are typically more accurate than routine stress tests, and can be used in both women and men. Nuclear imaging is done in conjunction with a stress test of some sort depending on the patient and their other medical conditions. Usually, if the patient can walk adequately, he or she is asked to walk on a treadmill to stress their heart. If they are unable to walk due to arthritis, lung disease, or other medical problems, their hearts can be stressed using intravenous chemical agents such as dipyridamole(Persantine), dobutamine(Dobutrex), or adenosine(Adenoscan). Since the test does involve the injection of a small quantity of radioactive isotope, women of childbearing potential are usually studied after a normal menstrual cycle. If menses are particularly irregular or unreliable, a woman may be asked to have a pregnancy test immediately prior to the exam.

What does the test show? Blood pool studies (MUGA scans) are used to measure the size and strength of the heart's major pumping chamber, the left ventricle. This study can be used in conjunction with a stress test in very special situations, but it is done with the patient at rest. As of this writing, the MUGA scan is the most accurate, practical, reproducible measure of left ventricular function available. Itis most useful in situations when information about the changes in heart function over time is important, such as in patients who must take medicines that are

toxic to heart function for treatment of cancer. On the other hand, stress nuclear images are useful when we are looking for blockages in arteries feeding the heart and the complications of these blockages. These tests can show how much of the heart is being fed by a blocked artery, whether the heart has been damaged by previous heart attacks, the overall strength of the heart muscle, and whether nonfunctioning heart muscle is actually alive but unable to work because of a severely limited blood supply.

How is the test done? Nuclear cardiac tests use a small quantity of a radioactive tracer substance that is injected into the blood stream and then is taken up by blood cells or the heart itself. A special camera is used to take pictures of the distribution of the tracer in the body. For a stress test, two sets of pictures of the heart are taken. One set is taken with the patient at rest, the other after exercise. The pictures show where the heart is getting a good blood supply at rest and the exertion and where the blood supply is limited. The pictures are compared to each other and to a normal database for analysis and diagnosis. For a MUGA scan, usually only one set of pictures is taken with the patient at rest.

How long does it take? A stress nuclear study of the heart is a complicated exam with many steps. An IV line is inserted into a vein in the patient's forearm and the patient is then injected with a radioactive tracer. The tracer is allowed to circulate for at least 15 minutes, and then pictures of the heart are taken. The first set of pictures takes about 30 minutes. The patient then has some form of stress test that may take from 10 to 30 minutes. They are given a second dose of the radioactive tracer some time during the stress test. After the stress test, the patient is asked to rest for 30-60 minutes during which they are asked to drink water to flush the radioactive tracers out of the upper intestines. A second set of pictures is then taken, lasting about 20 minutes. All in all, the test usually takes 3-1/2 to 4-1/2 hours. MUGA scans also require an IV and injection of a radioactive tracer that must circulate in the blood stream for a time prior to imaging. This test, however only requires one set of pictures and no stress test, so it usually only takes about 1-1/2 to 2 hours.

How do I prepare for the test? Instructions should be given to you when the test is scheduled. In general, however, you will be asked to fast for several hours (usually 4-6 hours) prior to the test. If you are a diabetic, you will be asked to withhold any oral diabetic medications and any regular ("R") insulin until after the test. You will be asked to take only one half of your normal dose of long-acting insulin ("NPH", "L", "U", "70/30", etc.). If you are to have a stress test, you will also be asked to withhold diltiazem ("Cardizem", Tiazac", etc.) and beta blockers ("Lopressor", "Tenormin", "Inderal", "metoprolol", "atenolol", "propanolol", etc.) on the morning of the exam. You may bring your pills with you to be taken after the stress test. If you have questions, please call the office and ask!

What does the patient feel? In order to get the nuclear pictures, the technologist will have the patient undress from the waist up and usually have them put on a gown. Wires to an electrocardiogram monitoring machine will be stuck on the patient's chest. An intravenous catheter will be inserted in a vein in their forearm. Unfortunately, this requires the use of a needle and can be mildly painful for a few moments. The nuclear pictures are taken with the patient lying on their back with their arms held over their head on a narrow table while the

camera moves around them. How the patient feels next depends on how their heart is stressed. If they walk on a treadmill, they will feel tired, breathless, and perhaps experience chest discomfort. If Persantine is used for the stress test, the patient may become nauseated, breathless, flushed or headachy. Happily we do have a medication (aminophylline) that can quickly get rid of these side effects. The longest a patient usually feels poorly from Persantine is about ten minutes. If dobutamine is used, it can cause the patient to feel palpitations, shortness of breath and possibly some anxiety or chest discomfort. The dobutamine is usually given for 15-20 minutes and wears off within an additional 10-15 minutes.
What are the advantages of a nuclear cardiac study? For many patients, a standard stress test without any pictures taken of the heart is adequate. If the patient's baseline electrocardiogram is abnormal, however, a routine stress test may not be diagnostic and an imaging test like the nuclear study is essential. In addition the routine stress test is notoriously unreliable in women where false test results are common. Nuclear stress tests are able to accurately assess both women and men. In addition, the nuclear test can give valuable information about how much of the heart is in trouble, which can help your physician plan the most appropriate therapy for you. Finally, additional information about heart strength is easily attainable with nuclear tests but not with a standard stress test.

Is it dangerous? Routine exercise stress tests are very safe for the diagnosis of coronary disease. The risk of a serious complication in the general population is less than 1 chance in 2,000. The addition of nuclear imaging to the exam does not increase this risk. The amount of radiation received by the patient in the course of the exam is roughly equal to what a patient might receive during a routine series of abdominal x-rays, and less than one would receive during a CT scan of the chest. An exercise test should not be done in patients with acute unstable angina, uncontrolled arrhythmias, uncompensated heart failure, critical aortic stenosis, severe obstructive hypertrophic cardiomyopathy, or uncontrolled hypertension in order to keep risk at a minimum. If dobutamine is used to stress the heart, the risk of a serious complication is somewhat higher (about 3 chances in 1,000 of a serious side effect) but still quite low. Certainly, the risk of complications with undiagnosed or misdiagnosed coronary atherosclerosis is much higher.

Conclusion: Nuclear cardiac testing is a versatile technique for safely and accurately evaluating coronary heart disease including its risks and complications. It can be performed in a wide variety of patients in the cardiologist's office or in the hospital.