NUCLEAR MEDICINE

Procedure: Nm
Bodypart: -
Patient Group: Female Male Child

Summary

Other terms: Radionuclide Imaging, Scintigraphy, Radionuclide (Isotope) Scan

Nuclear medicine is a branch of medicine and medical imaging that uses the nuclear properties of matter in diagnosis and therapy. Many procedures in nuclear medicine use radionuclides, or pharmaceuticals that have been labeled with radionuclides (radiopharmaceuticals). In diagnosis, radioactive substances are administered to patients and the radiation emitted is measured. The majority of these diagnostic tests involve the formation of an image using a gamma camera. Imaging may also be referred to as radionuclide imaging or nuclear scintigraphy. Other diagnostic tests use probes to acquire measurements from parts of the body, or counters for the measurement of samples taken from the patient. In therapy, radionuclides are administered to treat disease or provide palliative pain relief. For example, administration of Iodine-131 is often used for the treatment of thyrotoxicosis and thyroid cancer.

Nuclear medicine imaging tests differ from most other imaging modalities in that the tests primarily show the physiological function of the system being investigated as opposed to the anatomy. In some centres, the nuclear medicine images can be superimposed on images from modalities such as CT or MRI to highlight which part of the body the radiopharmaceutical is concentrated in. This practice is often referred to as image fusion or co-registration.

Nuclear medicine diagnostic tests are usually provided by a dedicated department within a hospital and may include facilities for the preparation of radiopharmaceuticals. The specific name of a department can vary from hospital to hospital, with the most common names being the nuclear medicine department and the radioisotope department.

Images from gamma cameras are used in Nuclear Medicine to detect regions of biological activity that are often associated with diseases. A short lived isotope, such as 131I is administered to the patient. These isotopes are more readily absorbed by biologically active regions of the body, such as tumors or fracture points in bones.

Technique
What it is

Nuclear medicine is the name given to the use of radioactive isotopes linked to certain chemicals to produce an image of different parts of the body. These isotopes emit gamma rays, which are similar to X-rays. The radiation does not stay in your body for very long, as the isotope decays within a few hours. The isotope preparation is generally injected into a vein, but may be swallowed or inhaled, and is taken up by a specific organ. Radiation from the isotope is then detected by a special camera, called a gamma camera, and an image is produced on a television screen. Unlike ordinary X-rays, nuclear medicine can also be used to show how well an organ is working, as well as what it looks like.

How it works

Diagnostic tests in nuclear medicine exploit the way that the body handles substances differently when there is disease or pathology present. The radionuclide introduced into the body is often chemically bound to a complex that acts characteristically within the body; this is commonly known as a tracer. In the presence of disease, a tracer will often be distributed around the body and/or processed differently. For example, the ligand methylene-diphosphonate (MDP) can be preferentially taken up by bone. By chemically attaching technetium-99m to MDP, radioactivity can be transported and attached to bone for imaging. Any increased physiological function, such as due to a fracture in the bone, will usually mean increased concentration of the tracer. This often results in the appearance of a ‘hot-spot’ which is a focal increase in radio-accumulation, or a general increase in radio-accumulation throughout the physiological system. Some disease processes result in the exclusion of a tracer, resulting in the appearance of a ‘cold-spot’. Many tracer complexes have been developed in order to image or treat many different organs, glands, and physiological processes. The types of tests can be split into two broad groups: in-vivo and in-vitro:

- In-vivo tests are measurements directly involving the patient. By far the most common are gamma camera imaging investigations, though non-imaging probes are also used to measure the levels of radioactivity within a patient.
- In-vitro tests are measurements of samples taken from the patient (e.g. blood, urine, breath).

Purpose

The purpose of a nuclear medicine scan is to locate areas of impaired function in the organ or bone being scanned. Nuclear medicine scans are widely used for diagnosis and monitoring of many different conditions. In the diagnosis and treatment of cancer, nuclear medicine scans are used to identify cancerous sites, for tumor localization and staging, and to judge response to therapy.

Target Patient Group
A nuclear medicine scan is an extremely sensitive test that can provide information about the structure and function of specific parts of the body. Types of nuclear scans include bone scans, heart scans, lung scans, kidney and bladder scans, thyroid scans, liver and spleen scans, and gallbladder scans. Brain scans are done to detect malignancy.

A typical nuclear medicine study involves administration of a radionuclide into the body by injection in liquid or aggregate form, inhalation in gaseous form or, rarely, injection of a radionuclide that has undergone micro-encapsulation. Some specialist studies require the labeling of a patient's own cells with a radionuclide (leukocyte scintigraphy and red cell scintigraphy). Most diagnostic radionuclides emit gamma rays, while the cell-damaging properties of beta particles are used in therapeutic applications. Refined radionuclides for use in nuclear medicine are derived from fission or fusion processes in nuclear reactors or cyclotrons, or take advantage of natural decay processes in dedicated generators, i.e. Molybdenum/Technetium or Strontium/Rubidium.

The most commonly used liquid radionuclides are:

- Technetium-99m (technetium-99m)
- Iodine-123 and 131
- Thallium-201
- Gallium-67
- Fluorine-18
- Indium-111

The most commonly used gaseous/aerosol radionuclides are:

- Xenon-133
- Krypton-81m
- Technetium-99m Technegas®
- Technetium-99m DTPA

**Positron emission tomography (PET)**

Positron emission tomography (PET) is a non-invasive scanning technique that utilizes small amounts of radioactive positrons (positively charged particles) to visualize body function and metabolism.

**Single photon emission computed tomography (SPECT)**

A technique that provides three-dimensional computer-reconstructed images of multiple views and function of the organ being imaged.

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**Procedure**

**Persons**

You will be cared for by a small team comprising mainly radiographers. A radiologist will subsequently examine the record of the images prior to writing a report on his/her findings.

**Preparation**

The required preparation for nuclear medicine scans ranges from slight to none. The doctor may advise that certain prescription medications be discontinued before the test or that the patient not eat for three to four hours before the test. Depending on the type of test, a reference scan or specialized blood studies may be done before the scan is taken. Jewelry or metallic objects should be removed.

The patient should advise the doctor of any previously administered nuclear medicine scans, recent surgeries, sensitivities to drugs, allergies, prescription medications, and if there is a chance that she is pregnant.

**Precautions**
Women who are pregnant or breast feeding should not undergo this test. A patient who is unable to remain still for an extended period of time may require sedation for a nuclear medicine scan.

**Duration**
Depending on the type of scan, the procedure may take anywhere from 15 to 60 minutes.

**Process**
In a nuclear medicine scan, a small amount of radioactive material, or tracer, is injected or taken orally by the patient. After a period of time during which the radioactive material accumulates in one area of the body, a scan is taken by a special radiation detector, called a radionuclide scanner. This machine produces an image of the area for analysis by the medical team.

This test is performed in a radiology facility, either in a hospital department or an outpatient x-ray center. During the scan, the patient lies on his or her back on a table, but may be repositioned to the stomach or side during the study. The radionuclide scanner is positioned against the body part to be examined. Either the camera, the table, or both, may change position during the study. It is important for the patient not to move except when directed to do so by the technologist.

**Experience**
Apart from the normal injection you will not feel anything.

**After procedure**
No special care is required after the test. Fluids are encouraged after the scan to aid in the excretion of the radioactive material. It should be almost completely eliminated from the body within 24 hours.

**Factors affecting results**
It is important for the patient not to move except when directed to do so by the technologist.

**Results**
The radiologist will examine your scan shortly after your visit, and will write a report on the findings. This may take some time to reach your referring doctor, but it is normally available in less than 14 days. You could ask the radiographer for some indication of timing.

**Normal results**
A normal result is a scan that shows the expected distribution of the tracer and no unusual shape, size, or function of the scanned organ.

**Abnormal results**
Depending on the tracer and technique used, the scan can identify and image particular types of tumors or certain cancers. Too much tracer in the spleen and bones, compared to the liver, can indicate potential hypertension or cirrhosis. Liver diseases such as hepatitis may also cause an abnormal scan, but are rarely diagnosed from the information revealed by this study alone.

In a bone scan, a high concentration of tracer occurs in areas of increased bone activity. These regions appear brighter and may be referred to as "hot spots." They may indicate healing fractures, tumors, infections, or other processes that trigger new bone formation. Lower concentrations of tracer may be called "cold spots." Poor blood flow to an area of bone, or bone destruction from a tumor, may produce a cold spot.

**Consideration**

**Risks**
The risks of nuclear medicine scans are very low. Most scans use the same or less amount of radiation as a conventional x-ray and the radioactive material is quickly passed through the body. Side effects or negative reactions to the test are very rare.
Citations

28 - "Royal College of Radiologists: Information for Patients Having an Isotope Renogram (CRPLG/30), Issue May 2003 http://www.rcr.ac.uk/docs/patients/worddocs/radleafnmrenogramf2.doc"