SPECT & Gamma Camera

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Overview

SPECT (Single-Photon Emission Computed Tomography) is a diagnostic imaging technique used in nuclear medicine which studies PHYSIOLOGICAL (FUNCTIONAL) processes in the body. Gamma cameras are used to construct an image of the distribution of radiopharmaceuticals spread out in the body of a patient.

Principle

The principle of this diagnostic method is to administer a radiopharmaceuticals which emits gamma radiation (mostly 99mTc) to the patient and then take multiple scintigraphic images from different angles. One or more gamma cameras rotate around the patient in small angular steps. The distribution of radiopharmaceuticals in the patient is then mathematically calculated from the individual images using the method of backward filtered projections or iterative algebraic reconstruction. Modern machines are replacing hybrids - there is SPECT for the PHYSIOLOGY and low-dose CT for the ANATOMY combined in one. They enable observing anatomical and functional properties of a tissue.

Capture of the radiation

One to three gamma cameras rotate around the long axis of a patient, which enables them to capture the radiation from different angles and then to create transversal, frontal and sagittal cuts. This results in creating a 3D image.

Gamma camera detection head

Collimator is a several inches tall lead plate which is located right before the crystal. It has several thousands of parallel passages that are perpendicular to the crystal. Collimator only passes the photons that come in a perpendicular direction, which results in greater accuracy of the resulting image.

Crystal is the place where the scintillation (conversion of gamma to visible light) happens. It is usually made of sodium iodide in a shape of a circle or a rectangle. It is 40-50 cm wide and 1 cm thick.

Photomultipliers

Photomultipliers are placed behind the crytstal in a pattern such that the position of the scintillation can be calculated. More than 90 photomultipliers can be used for higher accuracy. Every single photomultiplier registers that there has been a scintillation of photon in the crystal.

Lead shielding

The whole system is covered with a lead shield that prevents environmental radiation not coming directly from the patient from reaching the crystal..

Usage

SPECT can be used in cardiology, neurology or oncology. It shows the function of a organ or a metabolical activity of a part of the body, but it doesn’t show its anatomical structures (MRI or CT can be used for that).

Cardiology: The functioning of the heart muscle is examined in cardiology - myocardial perfusion imaging (mpi; ischemic heart disease), metabolism of the myocardium. The examination has two parts - before and after physical exercise. The lungs or the venous system can be examined, too.

Neurology: The blood circulation in the brain is examined in neurology. It can localize the afflicted area and help diagnose the disease (dementia, Alzheimer’s disease, Parkinson’s disease). It can also find the exact place where an operation of the brain could be done (epilepsy - double examination - before and during the seizure)

Oncology: SPECT helps with the localization of tumors. It is used during lymphoscintigraphy, examination of the sentinel nodes, etc. Other changes of metabolism Localization of inflammation, injury or joint disease.

Advantages and disadvantages

The advantage of SPECT is that it's like all nuclear medicine techniques it studies physiology. The disadvantage is that sometimes really inaccurate results occur owing to photos from Compton or photoelectric scattering reaching the crystal - however good collimators prevent this quite well. The radiation dose of an examination depends on the activity injected into the patient and the effective half-life of the radiopharmaceutical. Another disadvantage is the long time of the examination.