81mKr Ventilation Scintigraphy

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1. Introduction

Ventilation scintigraphy using ^{81m}Kr gas is always used in combination with perfusion scintigraphy. The principle of gas ventilation is imaging of the lung ventilation with ^{81m}Kr during tidal breathing.

In healthy individuals the ventilation and perfusion of the lung is matched. In the event of pulmonary embolism, ventilation is preserved wheras perfusion shows a defect. In those with parenchymal lung disease, matched ventialtion and perfusion defects occur, whereas in acute infection the ventilation defect may exceed the perfusion defect.

2. Methodology

This guideline is based on available scientific literature on the subject, the previous guideline (Aanbevelingen Nucleaire Geneeskunde 2007), international guidelines from EANM and/or SNMMI if available and applicable to the Dutch situation.

3. Indications

- In combination with a perfusion study, to determine the likelihood of pulmonary embolism
- Quantification of regional pulmonary function before oncological pulmonary surgery, lung volume reduction surgery and lung transplantation surgery

4. Relation to other diagnostic procedures

Ventilation scintigraphy can also be performed with aerosols. ^{99m}Tc DTPA is the most commonly used radiopharmaceutical. ^{99m}Tc sulfur colloid is another option and has slower clearance from the lungs. ^{133}Xe for ventilation studies is not available in the Netherlands

In some studies perfusion scintigram showed comparible results when combined with a normal chest x-ray in stead of a normal ventilation scintigram.

The introduction of the Multidetector CT angiography (MDCT) with high spatial and temporal resolution and good quality of arterial opacification has made this technology the method of choice for imaging pulmonary vasculature in lots of hospitals. It allows adequate visualisation of the pulmonary arteries up to at least segmental level. Another advantage of MDCT is the finding of an alternative diagnosis.

5. Medical information necessary for planning

- History (onset of complaints, history of VTE)
- Results of a D-dimer test
- Determination of the pretest probability of pulmonary embolism by for example the Wells-score
- A recent (within 24 h) chest X-ray
- Prior lung scintigraphy findings

6. Radiopharmaceutical

Tracer: ^{81m}Kr obtained from an ^{81}Rb generator
Nuclide: Krypton-81m
Activity: between 40-400 MBq, depending on the strength of the generator.
Administration: continous inhalation from the generator by a mouthpiece

7. Radiation safety

Because of the very short half-time, there are no special precautions for patients who are pregnant or breastfeeding.
Adult perfusion radiation dose: 0,05-0,10 mSv
Perfusion SPECT-CT: 1,2-4 mSv (dependent of the tissue density of the scanning area)

8. Patient preparation/essentials for procedure

Patient preparation

- The procedure of inhalation should be explained to the patient.

Procedure

- Ventilation scintigraphy should be performed in the same position as the perfusion scintigraphy.
- SPECT (with or without CT) may be useful in defining the size and location of the ventilation-perfusion defects (individual segments). In several studies it is suggested to increase the diagnostic accuracy and to reduce the number of nondiagnostic scan results.

9. Acquisition and processing

Planar images

Energy: ^{81m}Kr setting, 190 keV
Window: 15%-20%
Collimator: LEGP/MEAP collimator
Counts: 500 Kcounts per view
Computer: 128x128 or 256x256 matrix

Ventilation imaging should be performed in the following directions: anterior, posterior, right posterior oblique and left posterior oblique. Upon indication right lateral, left lateral, right anterior oblique and left anterior oblique views may be obtained.
Imaging in the upright position is preferable in order to increase chest cavity size and to minimize diaphragmatic motion. If necassary, images can be obtained in the supine position.

SPECT

Energy: ^{81m}Kr setting, 190 keV
Window: 15%-20%
Collimator: LEAP/MEAP collimator
Counts: Ventilation: 10-20s per projection
Computer: 128x128 or 64x64 matrix

10. Interpretation

Ventilation scintigraphy should be performed within 24 h after the perfusion study because perfusion defects can resolve within 24 h.The interpretation should include an

overall assessment of the likelihood of pulmonary embolism based on the scintigraphy findings. Most frequently used criteria for lung scan interpretation are the Modified PIOPED criteria or the PISAPED criteria. Normal perfusion scintigraphy rules out pulmonary embolism (>90%), two or more segmental perfusion defect indicate a high probability of PE (>90%).
The experienced nuclear medicine physician might be able to provide a more accurate interpretation of the lung scintigraph than is provided by criteria alone, by using a Gestalt interpretation. Such interpretation is usually based on detailed knowledge of the various, well known, lung image interpretive criteria.
In the group of high risk patients the report can advise repetition of the lung scintigraph at the end of the period of anti-coagulation therapy to evaluate the response.
Interpretation of preoperative lung scintigraphy should give the percentage of ventilation/perfusion in the rectangular lung regions or more frequently in the left and right lung. (See lung perfusion scintigtaphy)

11. Report

The report should be a combination of the result of the ventilation and the perfusion study (see perfusion scintigraphy)

12. Literature

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