LUNG VENTILATION STUDY
(Xe-133 Gas)

Overview

- The Lung Ventilation Study demonstrates the distribution of ventilation, air space, and air trapping within the lungs in the posterior projection, but images in other projections can be acquired secondarily.

Indications

- Diagnosis of pulmonary embolism, particularly when helical CT is contraindicated because of renal insufficiency or a history of a bona fide contrast reaction (1-4).

- Evaluation of regional ventilation (5,6).

Examination Time

- Initial POST images: 20 minutes.

- Optional reventilation images in other projections: 20 minutes each additional projection (7-9).

Patient Preparation

- Rehearse the patient through the breathing maneuvers required for image acquisition.

Equipment & Energy Windows

- Gamma camera: Large field of view.

- Collimator: Low energy, high resolution, parallel hole.

- Energy window: 20% window centered at 80 keV.

- Gas dispenser with return trap and 3 way valve.

Radiopharmaceutical, Dose, & Technique of Administration

- Radiopharmaceutical (10): Xe-133 gas.

- Dose: 20 mCi (740 MBq).

- Technique of administration: Xenon delivery system with trap:
  1. Fit the patient with a tightly fitting mask or a mouth piece and nose clamp.
  2. Attach the xenon delivery system for injection of Xe-133 gas and collection of exhaled Xe-133 gas.
  3. Set the valves so the patient is breathing from and into the xenon system, i.e. a closed system.

Patient Position & Imaging Field

- Patient position: Sitting (supine if unable to sit).

- Imaging field: Entire lungs; the Xe-133 dose may be used as a transmission source to ensure that the lungs are all within the field of view.

Acquisition Protocol (4)

- Be sure a new external filter is in the gas delivery system.

- Acquire images in the POST projection.

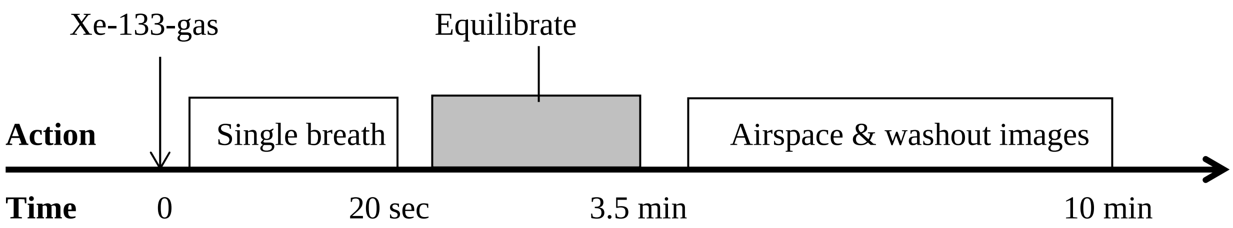
- Acquire a single breath (ventilation) analog image: (the system is closed
  1. Instruct the patient to take a deep breath as the Xe-133 gas bolus is injected into the delivery system and then hold the breath as long as possible.
  2. Acquire a 100 K count image or 20 seconds.
  3. If the patient starts to breathe before the acquisition is done, go to equilibration.

- Acquire an equilibrium (airspace) analog image: (the system is closed)
  1. Acquire one to three one-minute images.

- Acquire a series of washout (airway obstruction) analog images: (system is opened)
  1. Change the system valve so that the patient breathes room air in and exhales Xe-133 into the system trap.
  2. Beginning immediately, acquire sequential one-minute images until the Xe-133 gas is gone as judged from the persistence scope. Acquire a minimum of 4 images. If activity is still seen the fourth image, then keep the patient connected to the system until all the trapped activity is gone.

- Close the xenon delivery system and remove the mask from the patient’s face.

Protocol Summary Diagram



Data Processing

- None.

Optional Maneuvers

- Reventilation studies (7,8): If after seeing the initial ventilation study and the perfusion study, the nuclear medicine physician determines that a reventilation study is needed in another projection, proceed as follows:
  1. Reposition the patient in the selected projection; emphasize to the patient the importance of not moving throughout the entire image acquisition sequence.
  2. Acquire a repeat perfusion image using the Tc-99m energy window.
  3. Acquire a “Tc-99m scatter image” using the Xe-133 energy window. Acquire this image for the same time that the single breath image requires, approximately 20 seconds.
  4. Repeat the ventilation acquisition outlined above without moving the patient.

- Alternative radiopharmaceuticals: In some countries and localities Kr-81m gas (11) and Xe-127 gas (12) are available and may be substituted for Xe-133. Some protocol changes are necessary.

Principle Radiation Emission Data - Xe-133 (13)

- Physical half-life = 5.25 days.

Radiation	Mean % per disintegration	Mean energy (keV)
Beta-2	99.3	100.5
Ce-K-2	52.0	45.0
Ce-L-2	8.5	75.3
Ce-M-2	2.3	79.8
Gamma-2	37.1	81.0
K alpha 2 x-ray	13.3	30.6

K alpha 1 x-ray	24.6	31.0
K beta x-rays	8.8	35.0

Dosimetry - Xe-133 Gas (14-16)

Organ	rads/20 mCi	mGy/740 MBq
Lungs	0.17	1.7
Whole body	0.002	0.02
Brain	0.001	0.01

Dosimetry - Kr-81m Gas (14)

Organ	rads/mCi-min	mGy/MBq-min
Tracheal mucosa (surface)	0.46	0.12
Lungs	0.0025	0.0067
Whole body	0.000067	0.000018

References

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Normal Findings

> Stein MG, Waxman AD, Ramanna L, et al: Postperfusion xenon-133 ventilation scintigraphy with a narrow window. Am J Roentgenol 145:511-515, 1985.

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