EVALUATION OF REGIONAL PULMONARY VENTILATION USING POSITRON EMISSION TOMOGRAPHY AND N-13 NITROGEN GAS:

1) PRINCIPLES AND METHOD.

We have developed a new method to evaluate pulmonary ventilation quantitatively using N-13 labeled nitrogen gas which is 13 times less soluble in blood than xenon. The nitrogen gas is produced from CO2, through (p, n) reaction in a cyclotron, and rebreathed in a baby cyclotron, Cyprus.

The subject is allowed to rebreathe 20mCi of radioactive nitrogen gas diluted with 15 liter of oxygen gas in a closed circuit. After the global activity of the lungs reaches equilibrium a 3-minute scan (EQ) is performed. Then the patient inspires the room air to wash out the radioactive nitrogen gas and another scan (WO) is performed during the washout phase.

The EQ image has delineated defects caused by pulmonary arteries. The regional activity in WO phase images divided by that in EQ should yield time constant of regional ventilation on condition that regional activity follows single exponential compartment model and the dead space is disregarded. Thus our method provide regional pulmonary ventilation parameters quantitatively and in high resolution.

2) COMPARATIVE STUDY WITH C-13 NITROGEN GAS.
Ye-133 have been widely used for evaluation of regional pulmonary ventilation. However, its significant solubility in blood and low energy gamma-ray emitted by Ye-133 limit the accuracy of ventilation study. Our new ventilation study using positron emission tomography (PET) and N-13 probably overcome most of these problems because of low solubility of N-13 in blood and precise attenuation correction of PET. Fifteen patients including 13 with chronic obstructive pulmonary disease underwent PET with N-13 and Ye-133 studies. Compared to Ye-133 images, PET images proved to be more sensitive for detection of mild obstructive changes than Ye-133 images. PET images also demonstrated peripheral air trapping in patients with chronic bronchitis or bronchial asthma, and irregular areas of ventilation abnormality in the central zone of the lung in patients with pulmonary emphysema. PET with N-13 shows to be more accurate localization and quantitation of ventilation abnormality.

FUNCTIONAL MAP DISPLAY OF POSITRON GASES FOR ASSESSMENT OF DIFFUSION IN DISEASED LUNG.
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C15O2, 11CO2 and 13CO were produced by an in house cyclotron to assess regional diffusing capacity of the lung. Using a Y-camera, breath holding images were taken serially after inhalation of the positron gases. Regional clearance rate was obtained by computer analysis of first exponential component of the time-activity curves. Regional clearance indices were calculated as (initial-10 sec. images)/initial images, which was displayed as functional map.

5 healthy volunteers and 15 patients with COPD and 15 with Pulmonary fibrosis were studied. The whole lung clearance rate correlated well with DLCO/VA. The functional map showed higher clearance in lower lung field in normal controls and decreased clearance in the area corresponding to perfusion defects in COPD and Pulmonary fibrosis. Whereas, in certain fibrotic lung decreased clearance was also observed in regions with no evidence of perfusion defects.

The functional map display of positron gases is an useful indicator of the regional diffusing capacity of the normal and diseased lung.