Studies on Comparison Between Graphycal Analysis and Analysis by Using Simulation Model of the Washout Curve of Xenon-133

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It was attempted to compare values of ventilation function obtained from the simulation model with that obtained from the graphical backward projection technique.

The subjects were administered i.v. 5 m Ci of xenon and rebreathed xenon into closed circuit until xenon was uniformly distributed in the lungs. When equilibrium was achieved, the system was then closed off and the subjects breathed the room air while data are recorded on magnetic tape. The washout curves were corrected for the influence of xenon uptaken by the chest wall.

In order to analyze the curves by the simulation model, it was assumed that the lungs consisted of a common dead space and 6 regions which contained fast and slow compartments. Substituting the experimental data for FRC, dead space, tidal volume, and intial counts in the model, the washout curve of the model lungs could be computed and fitted to the experimental washout curve adjusting regional tidal volumes.

Furthermore regional ventilation is calculated from the same washout curves by the backward projection technique.

The values of ventilation obtained from the backward projection technique are equal to the values from the model assuming that the volume of dead space is equal to 0. However, under a physiological condition, a common dead apsce is being, and the turn over rate of ^{133}Xe is apt to decrease with time in the fast compartment and increase in slow compartment. Therefore ventilation cannot be exactly obtained from backward projection techinique.

Studies on Regional Pulmonary Function by Using Xe-133 and Computer-processed Scintigraphy

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Regional pulmonary functional studies used a large-view scintillation camera coupled with a 42000-parallel-hole-collimator and a computer with 16-K memories. Scintigraphic informations were

stored in a 32×32 matrix with 4 to 8 seconds intervals. The measurements were performed on a patient of sitting position.

At first ^{133}Xe gas was administered by the ventilation method using the closed-circuit spirometer. The breath-hold was performed in expiration and then in inspiration after the steady state of ventilation was attained. The regional ventilation index was estimated by regional subtraction between counts accumulated during the espiratory breath-hold and inspiratry one. At 7 min-later the washout of ^{133}Xe started. The regional washout half-time was calibrated by the regional washout curves. After the ^{133}Xe washout studies was completed, ^{133}Xe solution was intravenously administered with same position as the ventilation studies. The regional perfusion index was estimated by regional counts accumulated during the breath-hold just after administration.

The regional ventilation to perfusion ratio also calculated. The regional ventilation index, perfusion index, washout half-time and ventilation to perfusion ratio were measured on 7 normal cases, 10 patients of obstructive pulmonary diseases and 6 patients of the progressive systemic sclerosis. The regional pulmonary functional abnormality was disclosed on patients with normal composite pulmonary functions.

The Study of the Small Airway Disease Using Xe-133

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The methods using Xe-133 give the regional dynamic ventilation and blood flow of the lung, and, in addition, are the more sensitive method to analyse the peripheral small airway lesion. We have usually used the analysis of the washout after the intravenous injection of Xe-133 and the ventilation distribution after a bolus inhalation of Xe-133 at the reserve volume "RV-bolus method". The both methods were useful for detecting early small airway diseases. The delay of the washout from the lung region after the intravenous injection of Xe-133, showed the peripheral airway closure during normal breathing at rest, but RV-bolus method showed the airway closure at the reserve volume, as comparable to the "closing volume".

All of smoking in the subjects with the normal chest radiograph, showed the airway closure in the lower lung region, when inspiring as a bolus at the reserve volume, corresponding the losing volume in this dependent lung region, but during rebreathing, Xenon went to most of the whole lung. In the cases of early chronic bronchitis and the remission of the bronchial asthma, RV-bolus method showed the more extensive region of the airway closure than the washout method. But in the cases of the progressed chronic bronchitis and the bronchial asthma in attack, RV-bolus method showed almost the same region of poor or abscent ventilation as the washout method.

The airway disease (COPD) involves not only the peripheral small airway lesion but also the central airway lesion, and the latter lesion was detected by the aerosol scintigraphy.

RV-bolus method was the more sensitive for the early small airway disease, but, in the cases of the progressed airway disease, had no advantage over the washout method.