Analysis of Xe-133 Washout Process by Weighted Least Square Fitting

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Graphic peeling off method have been extensively used in the past for non-linear parameter estimation of Xe-133 washout curves from the kidney, brain and lung, which is assumed to be the multiexponential function.

However, several limitations of this techniques have been noticed that it is unable to separate parameters of similar magnitude with a high confidence, or to provide confidence limits for the parameter estimation without considering for a series of data to have different variance due to statistical fluctuation of radioactivities. In oder to overcome this problem, a computer program as written to successively fit to sum of two, three and four exponential term to the data by an iterative least squares techniques using a combination of the steepest descent and Newton-Raphson methods for convergence. Each data point was weighted by the reciprocal of its variance, assuming that the errors followed a Poisson distribution.

A compartment, i.e. an exponential term, was declared nonsignificant if it did not significantly reduce theleast squares error about the fitted line as judged by an F-test. Results of the analysis using a composite model curves of multiexponential function with random fluctuation revealed that weighting was essential to determine a plausible combination of compartments. Xe-133 washout process from lung was analyzed using this method, and compared with the result from that of the peeling off method.

Good correlations were found between these two providing that data were recorded long enough with enough radioactivities, suggesting the conventional peeling off method might be liable to be in a subjectivity.

Regional Significance of "Closing Volume"

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When considering the effect of prevailing air pollution on lung, early detection of small

airway disease has become important, but any conventional means have failed to detect it. Recently this type of change was known to cause premature closure of the small airway especially at dependent part of lung at lower lung volume, which is clearly evidenced by so-called "Closing Volume" as measured by the single expiratory curve using a bolus of tagging material such as 133-xenon. In this sense, it seems to be essential to validate this phenomena on the basis of regional lung function. At present, the closing volume was identified by means of scintillation camera imaging using 133-xenon.

Each of four healthy males under the age of fourty-five years old with or without history of cigarette smoking have been investigated, respectively. By rebreathing 133-xenon within a closed circuit, volume distributions (V) in lung at various level of respiration (RV, FRC, TLC) were recorded to be compared each other as spacial distribution. Upon normalizing averaged V distributions in a vertical direction, loss of volume changes from RV to FRC especially at dependent part of lung were significantly noticed in a group of smoker, whereas evenly distributed V changes were noticed in a group of non-smoker.

After intravenous injection of 133-xenon solution, the washout process from lung by tidal ventilation were also investigated to be expressed as a distribution of ventilation rate (λ) by computer processing. One of four smokers showed remarkable focal washout delay at dependent part of lung, while three of four smokers showed a evidence of regional washout delay or decrease of ventilation rate by the conventional compartmental analysis. Upon normalizing averaged distribution in a vertical direction, this tendency of decreased ventilation rate (λ) at the dependent part of lung was seen more evident in the smoking group than in the non-smoking group. By examining the relation between ventilation ($\dot{V}$) and perfusion ($\dot{Q}$) distribution, it was suggested that the loss of ventilation rate at the dependent part of lung at tidal ventilation might constitute the so-called physiological shunt effect on overall gas exchange efficiency of lung as was predicted by the computer simulation studies calculating A - a Do_2 theoretically by inputing the distributional relation between $\dot{V}$ or $\dot{Q}$ and $\dot{V}/\dot{Q}$.

^{131}I-MAA Lung Scans Processed by the Electronic Computer

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As previously reported[1)2)] we record lung scans in the paper tape with the routine scintigrams simultaneously. By using these tapes we processed the scintigrams with TOSBAC 40 TIME SHARING SYSTEM electronic computer. The anterior and posterior scintigrams were recorded with the Toshiba scintiscanner (φ : 3in) with the 37 hole collimator (the distance of focus: 10cm), after intravenous administration of ^{131}I-MAA to the sitting patient.

The quality of the images were compared