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A PROPOSAL OF A MODEL CONSIDERING WITH FINITE DIFFUSION SPEED.

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Using positron emission tomography (PET) and generator produced Ga-68-EDTA, dynamic blood-to-brain uptake of Ga-68-EDTA have been measured for human tumors in patients to obtain quantitative blood-to-brain permeability. Usual two-compartment analyses have been firstly performed assuming plasma and extracellular components, but in some data the prediction fails to reproduce the experimental data by using any parameter pairs. This discrepancy between the experimental data and the prediction would be caused by finite diffusion speed because most tumors have cystic lesions in which the capillary density is so thin that the tracer does not diffuse so instantaneously among the lesions.

A new model considering with the limited diffusion speed have been constructed, which has three parameters; forward and backward rate constants K_1 and k_2 and diffusion length L. The dynamic data of the Ga-68-EDTA uptake were well explained by using the present model.

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BRAIN OXYGEN UTILIZATION MEASURED WITH $^{15}O_2$ SINGLE INHALATION AND POSITRON EMISSION TOMOGRAPHY.

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Regional cerebral oxygen extraction fraction (OEF) and regional cerebral oxygen utilization ($CMRO_2$) has been measured using the steady state method with $^{15}O_2$ continuous inhalation and the positron emission tomography. However, important disadvantages of this technique include the relatively complex system required for constant delivery of the radiolabeled gases, and the long scan times during which, it is assumed, no change in physiologic state occurs.

Hence, the tracer administration method with single inhalation of $^{15}O_2$ gases has the advantage that the local cerebral oxygen consumption can be measured with PET scan of less than 1 min.

This rapid scan time is essential for studying the change of the cerebral oxygen metabolism to vasodynamic and neurophysiologic stimulation. We examined the difficulties of this method arising the accommodation to the clinical routine study.

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INTERRELATION BETWEEN OXYGEN EXTRACTION FRACTION AND CEREBROVASCULAR REACTIVITY MEASURED BY POSITRON EMISSION TOMOGRAPHY.

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Interrelations between oxygen extraction fraction (OEF) and cerebrovascular reactivity to $PaCO_2$ change ($CVRCO_2$) were measured on 11 cerebrovascular occlusion or severe stenosis patients and 5 moyamoya disease patients using O-15 steady state method, $H_2{}^{15}O$ autoradiographic method and HEADTOME III. Correlation coefficients of regional functions between OEF at rest and hypercapnic $CVRCO_2$ and hypocapnic $CVRCO_2$ were calculated. The correlation coefficients for hypercapnia were 9 negatives, 4 insignificants and no positive, and for hypocapnia 9 negatives, 4 insignificants and 2 positives. Under the hypothesis that vascular resistance was mainly controled by the partial pressure of CO_2 in brain tissue ($PbCO_2$) and OEF directly correlates with $PbCO_2$, these findings implies that a high OEF area has a low $CVRCO_2$ in response to elevation of $PaCO_2$, but there can have a high $CVRCO_2$ against high reduction of $PaCO_2$ so as to reduce $PbCO_2$ to regain vasoconstriction from the maximal vasodilatation.

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FUNCTIONAL MAPPING OF RATE CONSTANTS IN THE KINETIC MODEL OF FDG.

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Positron emission tomography (PET) offers the capability to evaluate biochemical processes in vivo. We have attempted to estimate rate constants of glucose metabolism pixel by pixel from serial dynamic PET images following intravenous injection of FDG. The Kinetic model of the glucose transport process is based on the three compartments with four rate constants. Curve fitting was performed by Newton-Raphson method providing the functional mapping of each parameter with the 95 % confidence limit. Regional cerebral metabolic rate for glucose (CMRG) were also calculated from individually fitted rate constants. Estimation of rate constants(k_1^*--k_4^*) and CMRG of each pixel can be performed in a few seconds on PDP/11-60 computer. Correction of blood volume effect was done by subtracting blood volume image by CO-15 from serial FDG images. While the rate constants maps were quite noisy because of random fluctuation, it offered accurate estimation by average values of a few pixels. In the healthy subjects,each constant almost coincided with the normal value. The k_3^* and CMRG of cerebellar were low. These rate constants images provide a useful mean for studying the glucose transport system in various organs and diseases.