334

IMAGING OF MYOCARDIAL PERFUSION USING PET AND O-15 LABELED WATER: A NEW METHOD TO SUBTRACT BLOOD POOL ACTIVITY.

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Myocardial images were obtained in positron emission tomography during the perfusion phase following one shot i.v. injection of 10 mCi of O-15 water. Those images, however, required subtraction of the blood pool activity overlaid upon the myocardium. The blood pool images were obtained in the same position following single inhalation of O-15 labeled CO gas. However, because a difference in activity exists between the left ventricular (LV) cavity and the right ventricular (RV) cavity, simple subtraction of the LV cavity activity using CO blood pool images induced significant over-subtraction in the right side heart including the interventricular septum and RV wall. We have developed a new method, "two-component subtraction", in which the CO blood pool images were decomposed into the right-side and left-side component using the early phase images following injection of O-15 water under the assumption that the whole activity of that phase was distributed in the right side heart homogeneously. Thus we subtracted the blood pool spillover from RV and LV separately and quantitatively improved the O-15 water myocardial perfusion images.

335

QUANTITATIVE MEASUREMENT OF MYOCARDIAL BLOOD FLOW USING $H_2{}^{15}O$ AND DYNAMIC POSITRON EMISSION TOMOGRAPHY: I. DEVELOPMENT OF A THEORY TO AVOID THE PARTIAL VOLUME EFFECT.

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In order to obtain the absolute value of the myocardial blood flow and metabolism function using PET, a model which includes the concept of "tissue fraction" has been developed. According to the present model, the concentration observed by PET can be described as

$$\alpha\, f\, Ca(t) * \exp(-f\, t)$$
$$\text{or} \quad k_1\, Ca(t) * \exp(-k_2\, t) \qquad (2)$$

where Ca(t) is the artery concentration [mCi/ml], α is the tissue fraction [g/min], f is the regional blood flow [ml/min/g] which is free from the partial volume effect, and * denotes the convolution integral. The model parameters (k_1, k_2) can be determined so that the calculated concentration curve, eq. (1), reproduces the measured dynamic data best by means of the least square fitting procedure. Hence, the absolute blood flow value and the tissue fraction can be obtained as k_2 and k_1/k_2, respectively.

336

QUANTITATIVE MEASUREMENT OF MYOCARIDAL BLOOD FLOW USING DYNAMIC POSITRON EMISSION TOMOGRAPHY: II. MEASUREMENT OF ABSOLUTE BLOOD FLOW AND ^{18}FDG RATE CONSTANT.

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On the basis of the model described in the previous paper, the kinetic study was performed. The PET scanning was started simultaneously with the i.v. injection of 15 mCi $H_2{}^{15}O$. The scan sequence consisted of 12 5-sec and 8 15-sec scans, total 3-min. The artery blood was withdrawn from femoral artery using a 0.5 mm diam. tube with 5 ml/min of withdrawal speed. To prove the validity of the present method, the MBF and tissue fraction were calculated for various sizes of ROI but in the same region of myocardium. When increasing the ROI size, the tissue fraction was reasonably decreased, on the other hand, the MBF values were almost constant. The study was performed for three normal volunteers. The averaged MBF value in septum, lateral wall and anterior wall was 1.05 ml/min/g.

The rate constants of the ^{18}FDG uptake in normal men was also calculated quantitatively using the obtained α values. $(k_1, k_2, k_3) = (0.112, 0.190, 0.440)$ and $(0.112, 0.190, 0.440)$ min^{-1} for fasting and post-prandial state, respectively.

337

THE CLINICAL SIGNIFICANCE TO MEASURE REGIONAL MYOCARDIAL BLOOD FLOW QUANTITATIVELY USING DYNAMIC PET AND O-15 WATER.

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This study was performed to measure regional myocardial blood flow(MBF) quantitatively using dynamic PET and O-15 water. The subjects were 4 patients with normal coronary angiography(CAG), 2 patients with angina pectoris(3-vessel disease) and 2 patients with myocardial infarction. O-15 water(15-20mCi) was injected into the cubital vein bolusly and dynamic PET was performed. MBF was calculated according to the method of Iida. The region of interest(ROI) was settled on the left ventricular wall (septum, anterior and lateral) and MBF was calculated in each ROI. In patients with normal CAG, MBF was 0.96-1.025 ml/min/g. In patients with angina pectoris, MBF was 0.532-0.647 ml/min/g in the ischemic area. In these patients, there was no definite defect on the MBF image but we could estimate the severity of coronary stenosis by quantification of MBF.The quantification of MBF is quite useful for the detection of 3 vessel disease non-invasively. The clinical advantages of this method is that we can estimate the severity of coronary arterial stenosis at the resting state.