GLOBAL QUANTIFICATION OF CARDIOVASCULAR NUCLEAR MEDICINE

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The direction that nuclear medicine is now taking is exemplified by cardiovascular nuclear medicine. Cardiologist have long been among the most physiologically oriented of all physician, interesting on quantification and validation of the data whenever possible. The increasing use of computers in nuclear medicine has permitted us to meet their strict requirements for quantification of functional information, both regional and global, to help solve their clinical problem.

The purpose of the present studies was to examine how one half aspect of global quantification without knowing regional information could contribute to meet their requirements. In fact, recently, some raised a question that the Anger camera would continue to be the predominant device especially in the cardiovascular nuclear medicine. For this reason, a single probe to detect solely temporal events of the first pass of the tracer through heart, called nuclear stetoscope, become revival nowaday, to made rapid bed-side evaluation of ejection fraction. However, this type of approach seems to be somewhat unreliable, because of its uncertaintly of positioning and its likelihood to be contaminated by higher frequency statistical noise. For this reason, the classical type of radiocardiogram (RCG) recorded by a wider collimator seems to be preferable and analyze it rather in medium frequency domain with less noise so as to obtain the mean transit time or constant flow/volume relation in each segment of the central circulatory system.[1)]
We routinely analyzed the RCG by the digital simulation method.[2)] Many useful parameters were obtained through this automated analysis by the usualy installed mini-computer, such as cardiac output (CO), right and left heart volume (RHV, LHV), pulmonary blood volume (PBV) etc. Good correlation was found between the LHV and the endo-diastolic left ventricular volume measured by the contrast ventriculography (r=0.94).

More than 80 patients suspected of ischemic heart disease (IHD) were subjected to be investigated, who were graded according to extent of ischemic defect on the 201 Tl myocardial perfusion imaging (MPI). At rest study, the most severely illed cases revealed significant increase of LHV. On exercise loading, while the control or mild equivocal cases did not revealed any appreciable change both of stroke volume and LHV, but established cases revealed increase of stroke volume with significant increase of LHV, indicating that those maintained normal cardiac function entirely depend upon the Starling's law. Furthermore, severely illed cases failed to increase stroke volume in spite of significant increase of LHV, indicating that those were in the state of the failing portion of Statling's law. In such occult state of the heart failure, the centralization of body blood was appeared to be characteristic, on exercise loading, namely simultaneous increase of RV and PBV were also present.

The 201-Tl MPI was also made global quantification, according to the indicator fractionation principle,[3)] on the assumption that the ratio of myocardial activity to the total injected activity might approximate fractional myocardial blood flow of the cardiac output (MBF/CO). This assumption was validated experimentaly by comparing the activity distribution of this tracer with that using the capillary blockade agent (r= 0.96). On exercise loading, the change rate of MBF/CO (ΔMBF/CO) in the normal control was 1.95±0.11, but in the hemodynamically insignificant IHD (< 70% stenosis) was 1.33 ±0.16 and in the hemodynamically significant IHD (> 70% stenosis) was 1.05±0.19, which was statistically significant decrease ($p < 0.001$). Hence, sensitivity to disclose the significant IHD as decreased Δ MBF/CO value less than 2SD of normal range become 100%, whereas the sensitivity of the conventional stress ECG was 77% and that of the stress MPI was 77%.[4)]

In summary, in favour of its non-invassiveness and simple manupilation, the global quantification should be done during the

intervention study such as exercise loading, and it was substantiated that this type of approach could surely potentiate the regional information, if a pertinent analysis is applied as we did here.

1) Ishii Y, et al. J Nucl Med 12:792,1971
2) Yonekura Y, et al. J Nucl Med 19:749,1978
3) Ishii Y, et al. J Nucl Med 19:708,1978
4) Ishii Y, et al. Proc of 2nd WFNM p.6,1978

NONINVASIVE DETECTION OF MYOCARDIAL ISCHEMIA FROM MYOCARDIAL SCINTIGRAPHY IN COMPARISON WITH CORONARY ANGIOGRAPHY

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To evaluate the size and location of myocardial ischemia quantitatively, myocardial perfusion imagings were studied clinically in the patients with coronary artery diseases.

(1). Clinical evaluation of various radiopharmaceuticals for myocardial imaging

Myocardial scintigraphies were performed in 185 cases of ischemic heart diseases using the potassum analog agalog agents (131-Cs, 81-Rb, 201-Tl). In the present study, thallium is most suitable for the detection of the perfusion defect, which has adequent gamma-energies and half lives. And the perfusion defects correlated best in thallium images in comparison with 81-Rb, 131-Cs, where the decay of 81-Rb to the noble gas, 81m-Kr would be applied to the measurement of regional myocardial blood flow in addition to the imaging. However, additional lead shielding was required for imaging because of abundant high energy gamma emissions.

(2). The location of myocardial infarction from thallium scintigraphy

Thallium myocardial imagings were performed in 44 cases of myocardial infarction. In 42 of all, the location determined from conventional ECG was coincided with that of image defect on a scintigram except the subendocardial infarction. Posterior defects were shown in 9 of 15 cases of inferior infarction and in the cases of pure posterior infarctions, the defects were detected clearly by the perfusion imaging. Therefore, this method is useful to detect the posterior infarction as well as anterior infarction. In comparison with angiographic findings, the location of defect area was correspond to the abnormally contracted region demonstrated on LVG. And findings of stenosis or obstruction in CAG did not show close correlation to the image abnormalities. In 3 cases of infarction, image defects were shown despite of under 50% stenosis of coronary arteries. And 7 cases of angina pectoris which had complete obstruction of coronary artery showed no defect on a scintigram. From these data, thallium perfusion images provide precise location of infarct and reflect the extent of necrotic mass, which show the viability of myocardium.