Symposium on Nuclear Medicine in Internal Medicine*

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1) Radioisotope Application in Diagnosis of Cardiopulmonary Diseases

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The remarkable progress in the application of radioisotope in diagnosis and clinical research work of cardiopulmonary diseases was accomplished during the last decade. Isotope methods have a distinguished feature as a far more harmless and simple method than conventional diagnostic approaches, which is especially desirable for patients with cardiopulmonary disease.

The several works in this field, which have been carried out in our Department, will be outlined in this paper.

I. Radioisotope indicator-dilution method for the hemodynamic study of congestive heart failure

Left ventricular performance was analyzed on 11 normal and 56 patients with various heart diseases in resting state. Several hemodynamic indices including end-diastolic volume (EDV), left ventricular forward fraction (LVFF) and mean circumferential shortening rate (MCSR) were measured by means of left heart catheterization and radioisotope dilution method using ^{131}I -Hippuran. Decreases in FSV and MCSR was more significantly related to the grade of severity of congestive heart failure, judged by more simple criteria, which consisted of presence of clinical signs of heart failure, decreased cardiac index, increased O_2 extraction ratio and presence of atrial fibrillation, than cardiac index and EDV. MCSR was also useful in the analysis of the effect of inotropic drugs and pressure- or volume-load on the left ventricle.

II. Radioisotope scanning of the heart

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(1) Cardiac blood pool scanning

RISA or recently introduced nuclides such as ^{99m}Tc or ^{113}In are used for this scanning.

Differentiation of dilated heart from pericardial effusion is quite easy when the X-ray cardiac shadow is compared to the photoscan of the cardiac blood pool as shown in the demonstrated cases. This technique is highly evaluated as the most appreciated tool among many kinds of radioisotope diagnostic methods in cardiac diseases.

(2) Cardiac muscle scanning—Direct visualization of myocardial infarct by photoscanning

Several radioisotope labeled substances have been used to visualize directly the region of myocardial infarct. The most popular indicator is ^{131}Cs , which is accumulated in normal cardiac muscle following intravenous injection, and infarcted region is visualized as "cold area" on photoscan. At present it is difficult to get a good scan in cases of diaphragmatic infarction, and further studies are needed to establish diagnostic value and indication of this method. However, the direct visualization of infarct may give some informations which cannot be available in electrocardiogram.

Another possible approach to visualize myocardial lesion due to coronary occlusion is a photoscan using ^{131}I -MAA injected into the coronary artery system. Photoscans of normal and infarcted canine hearts were demonstrated.

III. A radioisotope angiography by gamma-camera

To overcome the disadvantage of the scintiscanner which requires a long time to obtain a record, scintillation camera techniques have been introduced recently, and several kinds of apparatus are now available for dynamic visualization of cardiovascular system. Using a new type gamma-camera with two multistage image tubes which was devised in our Department with collaboration of Tokyo Shibaura Electric Co., and Anger-Camera, radioangiograms of cases of dextroversio cordis and tetralogy of Fallot were demonstrated to show that the technique can be used practically as a screening test. The techniques is extremely hazardless, while the resolution of the pictures obtained by gamma-camera is much poorer than X-ray angiogram at the present time.

IV. Studies on regional pulmonary blood flow by macroaggregated albumin (MAA) labeled with ^{131}I

Studies on regional pulmonary blood flow by means of ^{131}I -MAA were developed originally in U.S.A. for diagnosis of pulmonary embolism, and now ^{131}I -MAA pulmonary scan is becoming popular for cases with various types of pulmonary blood flow disturbance. Stimulated by this unique technique, many research fields on pulmonary function tests by radio-isotopes have been developed. So-called inhalation scan is a trial to get informations on disturbances of regional ventilation.

In primary pulmonary artery diseases, the scan by ^{131}I -MAA shows regional defects of the pulmonary circulation, whereas regional ventilation of the pulmonary region remains almost normal. In pulmonary diseases with restrictive pattern, both

of the regional pulmonary blood flow and the ventilation are decreased in parallel. In obstructive pulmonary disease disturbances of regional pulmonary flow are shown sometimes as irregular or multifocal defects on the scan. In pulmonary engorgement in mitral stenosis, pulmonary scan by ^{131}I -MAA indicates a relative increase in pulmonary blood flow in the apical regions while pulmonary blood volume determined by RISA is increased relatively in the basal regions. As seen in these examples, application of radioisotopes has made possible for regional disturbance of pulmonary functions to be visualized and to be estimated quantitatively.

V. Hemodynamic studies by catheter-type semiconductor radiation detector

Recently in our Department, for the *in vivo* measurement of the betaradioactivity in blood and tissue, a specially-designed catheter-type semiconductor was developed. The maximal outer diameter of the probe is about 2.7 mm., and characteristics of the detector such as sensitivity, linearity, durability and safety, are enough for clinical application. Following intravenous continuous infusion of ^{86}Kr saline solution, changes of right cardiac output can be measured continuously by the detector put in the pulmonary artery based on the flow-dilution relationship. Experimental data on dog were demonstrated. This equipment may be classified as a special type *in vivo* radioisotope measurement device.

VI. Study of digitalis metabolism by ^3H -digoxin

The pursuit of metabolism of digitalis in human body has become more practical after the introduction of ^3H digitalis preparations.

A study on serum levels and excretion of digoxin in the patients of renal failure after intravenous administration of tritium-labeled digoxin was demonstrated. In renal failure the clearance of digoxin in the circulating blood was markedly impaired, that is blood level of the isotope remained high for a long time, the urinary excretion was highly reduced and the fecal excretion was increased. Blood dialysis and peritoneal lavage revealed to have a little effect on removal of digoxin from the blood. From these observations it is evident that the kidney is the major organ for the excretion of digoxin, and that digoxin should be given carefully to the patients with renal failure to avoid digitalis intoxication.