K. Heart, Lung and Peripheral Circulation

Distribution Study of Thallium-204 by Autoradiography


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Myocardial scanning by thallium-201 is now proved to be important clinical tool for diagnosis of myocardial ischemia. Many papers were published in this application as well as basic studies of biological behavior of this radioisotope. However, no report was noted regarding histological or cytological distribution of this watersoluble radiouclide.

In this point, our investigation was undertaken to detect the tissue distribution of thallium by autoradiographic method. Experiments were performed using thallium-204, a β-emitter, instead of thallium-201. Twenty minutes after intravenous injection of the isotope into the mice, the animals were sacrificed, then, histological section were prepared by frozen section to avoid the escape of thallium ion from the tissues during process of routine paraffin preparation. The slides were processed for autoradiography, exposed for 5 days, then developed and stained by H and E.

The greatest homogeneous distribution of thallium-204 grain in autoradiography, among eight organs of mice, was the heart. The grains were distributed homogeneously throughout the heart muscle. In other five organs, liver, skeletal muscle, intestine, and spleen, grains were noted also homogeneously with lesser grade distribution than that of the heart.

On the other hand, specific focal concentration of isotope was observed in kidney and testis. In the kidney, almost all grains were located in the tubules and no activity was noted in the glomerulus. The grain distribution in the testis was specially characteristic and found in the Leydig cells with marked concentration. It is known that the change in distribution of thallium occurs with time in various organs. And images of myocardium after exercise show increased concentration of thallium when compared to resting-stage images of the same patient. However, importance of our study is to demonstrate the difference of tissue distribution of thallium ion in various organs. Especially the specific thallium concentration into the Leydig cells may suggest the presence of biochemical and/or biofunctional characteristic nature of its functions.

Evaluation of ²⁰¹Tl Myocardial Imaging


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When ²⁰¹TlCl was injected intravenously, 4.42% of administered dose or 4.04% ad. dose per gm tissue was accumulated in the heart of rats at 30 min. post-injection, which indicated the adequacy of the nuclide to be used for imaging of normal myocardium.

Scintiphotos in various projections obtained in a healthy volunteer after i.v. injection of 2 mCi of ²⁰¹TlCl (Phillip-Dufer-Daichi) revealed accumulation of radioactivity in the myocardium in doughnut
shape surrounding a slightly decreased radioactivity corresponding to the left ventricular cavity.

In patients with acute (AMI) or old myocardial infarction (OMI), focal defect in myocardial wall was demonstrated. The defect corresponded to the site of infarction demonstrated in ECG. All four patients with AMI revealed definite focal defects in the myocardial wall. Among patients with OMI, 4 showed definite defect, 3 were suspected of focal defect, one of whom was negative in the repeat study. In one patient with OMI, scan was interpreted as normal. Among 29 patients without M.I. 8 revealed scan showing hypertrophic left ventricle and the others showed normal scan. In a normal subject, the scan repeated after exercise showed increased accumulation of radioactivity in the myocardium with decreased background radioactivity (as compared with the scan at rest). Ratio of counts on the ventricular cavity to wall (c/w) in a control subject was 0.70 at rest and 0.84 at stress. The lung left ventricular wall ratio were 0.5 at rest and 0.31 at stress. Post exercise myocardial scan in patients with coronary heart disease is now under study.

**Correlation Between $^{201}$Tl-Myocardial Scintigraphy and Coronary Cineangiography**

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Myocardial imaging used $^{201}$Tl was performed in 39 patients who underwent coronary arteriography. In 17 patients with acute myocardial infarction, the defects of 14 patients were detected by visual inspection corresponding to coronary angiographic and electrocardiographic localization of the infarction. 12 scintigrams with old myocardial infarctions showed lesser defects compared with acute myocardial infarction, probably owing to reduction and improvement of ischemic lesion by the formation of collaterals. In 6 patients with angina pectoris and two other cardiovascular diseases, three scintigrams were questionable and 5 negative scintigrams were obtained.

Two each evidently abnormal scintigram in congestive cardiomyopathy revealed normal coronary arteriogram, large left ventricular end-diastolic volume and poor contractility. One patient’s ECG had left bundle branch block and the other had right bundle branch block.

5 patients undergoing aortocoronary bypass surgery were evaluated by preoperative and postoperative scintigraphic and coronary angiographic studies. In a patient with impending infarction who underwent double saphenous vein grafts, there was a significant improvement in the postoperative image when compared with abnormal preoperative one. The other postoperative scintigrams had no remarkable changes, but the left ventricles were smaller than preoperative ones, because of decrease of left ventricular end-diastolic volume.

$^{201}$Tl scintigraphy has proved to be of value to detect the presence, location and extent of infarction as well as the perfusion of the remaining myocardium. This noninvasive method will play an important role in the assessment of patients with ischemic heart disease, cardiomyopathy and aortocoronary bypass graft with further advance in instrumentation.