Application of Radionuclide Imaging in the Detection of Acute Myocardial Infarction

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Radionuclide imaging was useful for noninvasively visualizing a location and size of infarction in two patients with acute myocardial infarction. In one patient, inferior subendocardial myocardial infarction was detected by ^{99m}Tc -PYP myocardial scintigraphy and then inferior transmural infarction was observed as more intense radioactivity with a larger size. In the other patient with acute extensive anterior myocardial infarction, akinesis of the left ventricular wall and left ventricular aneurysm were confirmed by first-pass radionuclide angiocardiology and multigated equilibrium cardiac pool scan.

MYOCARDIAL imaging has been shown to be a useful method for noninvasively diagnosing the location and size of myocardial infarction.¹⁻⁴ Myocardial scintigraphy with technetium-99m pyrophosphate (^{99m}Tc -PYP) which shows the hot-spot scanning is being used to image acutely damaged heart and to attempt to define quantitatively the amount of dead heart muscle.^{5,6} On the other hand, thallium-201 (^{201}Tl) myocardial scintigraphy which demonstrates the cold-spot imaging is widely used to show the abnormalities of blood flow to infarcted or dead tissue of the heart.^{7,8}

Radionuclide angiocardiology is also valuable in noninvasively studying of a hemodynamics in patients with left ventricular dysfunction.^{9,10}

In this study, two cases of acute myocardial infarction were reported with special reference to radionuclide imaging.

Key Words:

Acute myocardial infarction
Technetium-99m pyrophosphate scintigraphy
Thallium-201 myocardial scintigraphy
First-pass angiocardiology
Cardiac pool scan

METHODS

The radionuclide imaging was performed 90 minutes after the intravenous administration of 15 mCi of ^{99m}Tc -PYP using a gamma scintillation camera (Picker Dyna Camera 4/15) with a high-resolution parallel-hole collimator and computer system for analysis (Gamma-11, DEC PDP-11/34).

The imaging was also performed 15 minutes after the intravenous administration of 2 mCi of ^{201}Tl -Cl.

First-pass radionuclide angiocardiology was obtained immediately after bolus injection of 15 mCi of ^{99m}Tc -human serum albumin (^{99m}Tc -HSA) in right anterior oblique projection and then multigated equilibrium cardiac pool scan was performed in left anterior oblique projection.

RESULTS

Case 1. I.S. 63y.o. male

He was admitted to the coronary care unit (CCU) of Nagoya National Hospital in 2 hours after onset of a sustained chest pain. An electro-

Fig.1.

cardiogram (ECG) recorded in another hospital demonstrated ST-segment elevations without abnormal Q waves in leads II, III and aV_F (Fig. 1A). An electrocardiogram recorded 12 hours later showed coronary T waves and no more ST-segment elevations and abnormal Q waves (Fig. 1B). Subsequent ECGs revealed non-transmural myocardial infarction suggestive of subendocardial infarction. Mild increases of white blood cell counts (WBC), the values of creatine phosphokinase (CPK), glutamic oxalacetic transaminase (GOT) and lactic dehydrogenase (LDH) were observed. On the fourth hospital day, scintigraphy with ^{99m}Tc-PYP was performed in the anterior (Ant), thirty degree left anterior oblique (LAO30), forty-five degree (LAO45) and sixty degree (LAO60) projections. Scintigrams demonstrated a small area with slightly increased but obscure radioactivity in the inferior wall of the left ventricle (Fig. 2).

He was suffered from severe chest pain on the fifth hospital day again. The ECG showed remarkable ST-segment elevations in leads II, III and aV_F (Fig. 1C). An ECG recorded in 4 hours after the second episode (Fig. 1D) demonstrated abnormal Q waves and slight ST-segment elevations in the same leads suggestive of transmural

inferior myocardial infarction, while the levels of CPK, GOT, LDH and erythrocyte sedimentation rate (ESR) significantly rose again. On the eighth hospital day (three days after a second episode), scintigrams showed more intense and extended ^{99m}Tc-PYP uptake in the inferior wall of the left ventricle (Fig. 3) than that of the first attack. Subsequent ECGs had shown abnormal Q and coronary T waves in leads II, III and aV_F. Myocardial imaging using ²⁰¹Tl was performed on the twenty-eighth hospital day and showed diminished radioactivity (defect) in the infero-posterior walls of the left ventricle (Fig. 4).

Case 2. H.O. 62y.o. male

An electrocardiogram demonstrated a finding of acute extensive anterior myocardial infarction in 5 hours after onset of chest pain (Fig. 5A). The values of WBC, CPK, GOT, LDH and ESR showed markedly increase during serial examinations. A myocardial scintigram was performed on the sixth hospital day, in which the diffuse and relatively faint uptake of ^{99m}Tc-PYP was observed in the antero-septal walls of the left ventricle (Fig. 6). Following ECGs showed persistent QS patterns with ST-segment elevations in leads V₁ to V₅ suggestive of left ventricular aneurysm

Fig.2. ^{99m}Tc -PYP scintigrams performed 5 days after the first attack in Case 1. The upper left; Ant, upper right; LAO 30, lower left; LAO 45, lower right; LAO 60 projections. Note low accumulation of ^{99m}Tc -PYP in the inferior wall of the left ventricle.

Fig.3. ^{99m}Tc -PYP scintigrams performed 3 days after the second episode on the eighth hospital day in Case 1. Note more intense and extended ^{99m}Tc -PYP uptake in the inferior wall of the left ventricle than that of Fig. 2.

Fig.4. ^{201}Tl scintigrams performed on the twenty-eighth hospital day in Case 1. Note reduced activity in the inferoposterior walls of the left ventricle.

Fig.5.

Fig.6. ^{99m}Tc -PYP scintigrams performed on the sixth hospital day in Case 2. Positive scintigrams showing the "doughnut" pattern in a patient with extensive anterior myocardial infarction.

Fig.7. Multigated equilibrium cardiac pool scan on the thirty-fifth hospital day in Case 2. The imaging lines were superimposed respectively at the end-diastole and the end-systole in the forty degree left anterior oblique projection. Note left ventricular asynergy in the apex.

Fig.8. First-pass radionuclide angiocardigraphy in the twenty degree right anterior oblique projection in Case 2. The imaging lines were superimposed at the enddiastole and the end-systole. Note left ventricular asynergy in the anterior wall to the apex.

Fig.9. ^{201}Tl scintigrams performed on the forty-third hospital day in Case 2. Note defect in anteroseptal and lateral walls of the left ventricle.

(Fig. 5B). Multigated equilibrium cardiac pool scan on the thirty-fifth hospital day demonstrated left ventricular asynergy in the antero-septal walls to the apex (Fig. 7). First-pass radionuclide angiocardiology also represented the same left ventricular asynergy as that in the cardiac pool scan (Fig. 8). A relatively extensive area of significantly reduced radioactivity in antero-septal walls to the apex corresponding to electrocardiographic localization of the infarction was found on ^{201}Tl myocardial scintigram (Fig. 9).

DISCUSSION

Radionuclide imaging is a well-suited technique for noninvasive assessment of myocardial infarction and ventricular performance,² because of visualizing a location and extent of infarction, asynergy, or aneurysm of the left ventricular wall.

Myocardial imaging with $^{99\text{m}}\text{Tc-PYP}$ has been reported to be a reliable technique in the diagnosis of acute myocardial infarction.⁵ As $^{99\text{m}}\text{Tc-PYP}$ scintigrams tend to become positive approximately 12 hours after acute myocardial infarction and then fade 7 days later, we performed this myocardial imaging procedure within the first 7 days after onset of symptoms suggestive of myocardial infarction. Characteristic patterns of localized intense uptake in acute transmural and diffuse uptake in acute subendocardial infarction, and negative scintigrams in angina pectoris have been observed.^{5,11} We also found low accumulation of $^{99\text{m}}\text{Tc-PYP}$ in the inferior subendocardial infarction and then intense uptake in the inferior transmural infarction in Case 1. Myocardial scintigraphy with $^{99\text{m}}\text{Tc-PYP}$ should be of diagnostic help in identifying whether or not ECG abnormality implies subendocardial infarction in patients admitted to the CCU with chest pain of various etiology. Ahmad et al.¹² reported that definite left ventricular aneurysm and dyskinesis had positive $^{99\text{m}}\text{Tc-PYP}$ myocardial scintigrams with activity localized to the site of the wall motion abnormality. Thus caution should be paid in interpreting positive $^{99\text{m}}\text{Tc-PYP}$ scintigrams as being indicative of acute myocardial infarction when evidence of a left ventricular aneurysm is also present.

The application of resting potassium-analogue, ^{201}Tl myocardial scintigraphy is now practical in evaluating of ischemic heart disease because of good qualitative relationships between location of ^{201}Tl myocardial perfusion defects and ECG,

ventriculography, cardiac enzymes, coronary arteriography, and postmortem studies.^{1,3,7,8} We considered that the present study showed a good correlation between the scintigraphic and ECG findings with regard to both location and size of myocardial infarction. Wackers et al.⁷ found that ^{201}Tl scintigraphy provided more precise location of infarction than the ECG and that the size of the scintigraphically abnormal area reflected the extent of necrotic myocardium. They also emphasized that ^{201}Tl scintigraphy provided an additional diagnostic aid in recognizing patients with acute myocardial infarction at high risk, especially in patients with abnormal ventricular activation pattern (i. e., left bundle branch block, pacemaker rhythm, WPW syndrome), where electrocardiographic diagnosis and the detection of localization in infarcted heart muscle was difficult. The data by Henning et al.³ indicated that ^{201}Tl was more accurate than $^{99\text{m}}\text{Tc-PYP}$ in detecting and localizing acute myocardial infarction in patients without prior infarction and that $^{99\text{m}}\text{Tc-PYP}$ might fail to identify small infarcts and tended to be underestimated in patients with inferior infarction.

Radionuclide angiocardiology provides non-invasive clinical assessment of left ventricular function. Accurate measurement of ventricular performance has usually required cardiac catheterization, however this procedure cannot be readily performed in acutely ill patients and is not without risk. We performed first-pass radionuclide angiocardiology and multigated equilibrium cardiac pool scan, and could find precise location and size of left ventricular asynergy in Case 2. These findings were agreement with localization and size of $^{99\text{m}}\text{Tc-PYP}$ accumulation and defect of ^{201}Tl scintigraphy. Left ventricular aneurysm localized in antero-septal walls to the apex was also documented by two-dimensional echocardiography in Case 2.

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