Clinical Significance of Radionuclide Studies in the Acute Phase of Myocardial Infarction

TOSHIHIDE TANAKA, M.D.*, YASUO TAKAYAMA, M.D.*, TAKAKAZU HAYASHI, M.D*
YOUICHI SHIMIZU, M.D.*, YUKIYOSHI ITO, M.D.*, MITSUKI ABE, M.D*
MITSUKAZU MATSUDA, M.D.*, YOSHIKO OBUNAI, M.D*
NORIKO KIKUKAWA, M.D., and KAZUYUKI CANNO, M.D**

TI$^{201}$ MPS and MGCBS were performed on patients with myocardial infarction in the acute phase and the results were evaluated using a scoring system. The findings obtained in this study can be summarized as follows. (1) There was a significant difference in RNEF between Killip class I and III. (2) Significantly high correlation was noted between RWM score and RNEF. (3) In cases of low RNEF (less than 35%) with poor RWM (less than 7), the incidence of complications, especially malignant PVC (47%, P < 0.01) was markedly high. (4) There was no obvious correlation between TI$^{201}$ MPS and complications. However, adding low RNEF (35% or less) to poor TI scores (−22 or less) malignant PVC was noted with high frequency. (5) TI scores on admission were not related to the number of coronary arteries involved. (6) For patients with good TI score and low RNEF on admission (suspected of having severe ischemia), EF did not necessarily showed a tendency toward improvement. (7) Patients with single-, tow- or three-vessel disease showed no difference in improvement of EF at discharge. (8) There was no marked difference in TI score on admission among three groups of single lesion of left anterior descending artery; patients with total occlusion without collateral circulation, patients with collateral circulation and patients with recanalization.

THE Radionuclide (RN) studies that provides for noninvasive monitoring of cardiac function in patients with myocardial infarction and estimating the expansion of the infarcted and ischemic areas are considered to be of high value. We have recently performed radionuclide ejection fraction (RNEF) by multiple gated cardiac blood pool scintigraphy (MGCBS) and TI$^{201}$thallium myocardial perfusion scintigraphy (TI$^{201}$ MPS) on patients with acute myocardial infarction early in its course and studied the results of these tests in relation to complications and angiographic findings obtained at discharge.

MATERIALS AND METHODS

Patient Population

The subjects of this study were selected from among the patients who were admitted to this hospital because of acute myocardial infarction between January 1981 and September 1982. Of them, 42 patients (36 males, 6 females) ranging in age from 38 to 74 years underwent MGCBS and TI$^{201}$ MPS within 48 hours of admission and

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* Department of Cardiology, ** Department of Radiological Technology, The Sakakibara Heart Institute, Tokyo Japan
Mailing address: Toshihide Tanaka, M.D., Department of Cardiology, The Sakakibara Heart Institute, 2-5-4 Yoyogi, Shibuya-ku, Tokyo 151, Japan

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cardiac catheterization at discharge and 16 patients underwent no cardiac catheterization at discharge. The subjects were classified according to Killip-Kimball's criteria into groups of 40 patients in class I, 12 patients in class II and 6 patients in class III. No patient was in class IV. All patients were treated according to a standard CCU protocol that included nasal oxygen, sedation with diazepam derivatives, nitrates, Ca++ antagonists and/or narcotics for chest pain and antiarrhythmics, mainly xilocaine, for ventricular arrhythmia. After CCU discharge the exercise was increased gradually according to our rehabilitation program. The cardiac catheterization was generally performed after 2 or 3 weeks of rehabilitation.

RN Studies

MGC BPS was performed, using a mobile scintillation camera (429 Ohio Nuclear) and a low-energy, high-resolution all-purpose parallel hole collimator in the anterior and LAO 45° planes, 10 minutes after intravenous administration of 99mTc-labeled albumin in a dose of 20 or 25 mCi. Data were obtained using a 64 × 64 matrix and each heart beat was equally divided into 16 intervals. RNEF was performed according to Parker. In the TI201 MPS, studies were made in the anterior, LAO 30°, LAO 60° and L-lateral planes, using the same camera and a high sensitivity collimator, 10 min after intravenous administration of 201Tl in a dose of 2.5 or 3 mCi. Data were taken, using a 128 × 128 matrix floppy magnet disk. The anterior and LAO 45° projections obtained in the MGC BPS study were divided into 8 portions, as shown in Fig. 1, and they were scored according to the following regional wall motion (RWM) degree: dyskinesia -1, akinesia 0, moderate to severe hypokinesia 1, mild hypokinesia 2, and normal contraction 3. The TI201 MPS was divided into 12 portions in 4 planes and they were scored according to the degree of perfusion defect: normal uptake 0, mildly decreased activity -1, definitely decreased activity -2, almost absent activity -3, and absent activity -4. The scores were evaluated by 3 experienced physicians, and when score evaluations differed, they agreed by consultation. The mean interobserver variation correlation was r = 0.93.
Cardiac Catheterization

Right heart catheterization, left ventriculography and coronary angiography were performed before discharge using the Sones or Judkins approach. Left ventriculography was performed in biplanes, and the RAO 30° and LAO 60° planes were divided into 8 segments as with MGCBS, and RWM was scored. EF calculation was done by Kennedy’s method. The correlation coefficient between RNEF and angiographic EF was 0.89. The subjects were positive for collateral circulation when it was clearly visualized.

RESULTS

Relationship between Killip Classification on Admission and Results of RNEF and TI201MPS

Figure 2 shows the relationship between Killip classification and complications in the hospital and the results of RNEF. There were no significant relationship of RNEF between Killip class I and class II, but RNEF was significantly lower in class III than in class I. There was no particular correlation between complications and Killip classification. Similar relationships were noted with TI201MPS, but the TI score was clearly decreased in class III.

Relationship between RNEF and RWM and TI Score

In the upper panel of Fig. 3, where RNEF is plotted as abscissae and the RWM score as ordinate, a significant positive correlation (r = 0.925, p < 0.01) between RNEF and RWM score is indicated. In the lower panel, the TI score is plotted as ordinate, and on the other hand in this figure there was not so better a correlation between TI score and RNEF as noted between RNEF and RWM. When RNEF was less than 35 percent and the RWM score was less than seven, incidence of complications was very high (80%, 12/15, p < 0.05; subclass C in Fig. 4). In particular as in Fig. 4, malignant...
PVC more than class III of Lown’s classification (VT & VF 3, VT 3, multifocal & bigeminy 1) occurred with high frequency (47%, 7/15, p < 0.01). When the TI score was -22 or less with RNEF of 35 percent or less, the frequency of malignant PVC was significant high (55%, 6/11, p < 0.05).

**Initial TI Score and Improvement of EF**

Figure 5 shows the relationship between the TI score and RNEF obtained at acute stage and the improvements in angiographic EF taken at discharge for single, double and triple vessel diseases. There was no relationship between TI score and the severity or number of coronary vessels involved. Good TI scores with low RNEF in the acute phase probably represented severe ischemia, but no marked improvement was noted in angiographic EF taken at discharge. There were 15 cases with single vessel disease involving left anterior descending coronary artery related myocardial infarction. Among them, 3 cases had total occlusion without collateral circulation, 5 with collateral circula-
tion, and 7 cases were recanalized. There was no difference in TI score and RNEF on admission and angiographic EF at discharge among these three groups of patients.

As is clear in Fig. 6, in which the improvement of EF is compared among single, double and triple vessel diseases, angiographic EF showed a significant improvement in 20 to 26% at discharge regardless of the number of vessels involved, as compared with the RNEF obtained on admission.

DISCUSSION

The RN technique that provides for relatively easy and accurate determination of left ventricular function in the acute phase of myocardial infarction and detection of the size of necrosis and the surrounding areas which are ischemic but may be retaining normal function, furnishes valuable information to the assessment of complications and prognosis. In the present study we have tried to answer the following questions; (1) What is the value of TI\textsuperscript{201}MPS in the acute phase of myocardial infarction in predicting the short-term prognosis? (2) Is there any correlation between RNEF and/or RWM scores and short term prognosis? (3) Which of the two variables does afford a better prognosis? Does data obtained from TI\textsuperscript{201}MPS add to the prognostic information obtained from the MGCBPS? Can these tests alone or in combination afford

* P<0.05, ** P<0.01

Fig.4. Relationship of complication among RNEF, RWM score and TI score.
A. TI Score and the Improvement of EF

![A. TI Score and the Improvement of EF](image)

Fig. 5.

B. The Degree of Improved EF on Single, Double and Triple Vessel Disease

![B. The Degree of Improved EF on Single, Double and Triple Vessel Disease](image)

Fig. 6.

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a better prognosis, as compared to simple clinical variables?; (4) What is the relationship between the RNEF on admission and the angiographic EF at discharge? What is the relationship between the Ti score and EF improvement? What is the difference of EF improvement between the presence or absence of collateral circulation and recanalization and (5) Are there any differences between positive and negative redistribution taken 4 to 6 hours after initial scintigraphy in assessing coronary arterial involvement, LV function, presence or absence of collateral circulation and recanalization? As Rigo\(^2\) and Pichler\(^3\) reported, the complications were increased in our cases where RNEF on admission was decreased, especially when RNEF was 35% or less and the RWM score was 7 or less, 7 of 15 patients were complicated with malignant PVC’s, 3 heart failures, and 2 cardiac ruptures. However, the relationship between EF and Killip classification on admission differed from the report of Sanford\(^4\); there was no significant difference in RNEF between Killip class I and class II. This is in part ascribable to the time lag between RNEF measurement and the classification. As Wackers\(^5\) pointed out, RNEF determined in the acute phase of myocardial infarction varies spontaneously from time to time. In consideration of this fact, it may not absolutely be necessary that RNEF correlates with Killip classification.

When the Ti score was \(-22\) or less, the incidence of malignant PVC’s was significantly high, but Ti\(^{201}\)MPS done in the acute phase of myocardial infarction did not seem to help improve the predictivity of short-term prognosis. Silverman\(^6\) performed Ti\(^{201}\)MPS within 15 hours of onset of the chest pain and found that patients showing low Ti scores carried a very poor prognosis, that is, much higher risks than the patients showing high Ti scores. As a matter of fact, Ti\(^{201}\)MPS which represents the sum of the areas of old damage, new necrosis and ischemic jeopardized myocardium theoretically be considered a very effective test to differentiate the high from low risk patients on admission.\(^7\) From a practical viewpoint, however, this examination poses hard problems to solve with respect to timing of intervention and evaluating the degree of perfusion defect. In our protocol, for instance, Ti\(^{201}\)MPS was performed within 48 hours of admission. During this period, however, the area of ischemia may disappear and the area of fresh infarction may be shrinking\(^8\) so that the area of ischemia and/or injuries may not be reflected in Ti\(^{201}\)MPS taken at that time. Further, when a minor perfusion defect or a borderline defect occurs adjacent to the infarction, it is extremely difficult to visually evaluate these defects in a proper way.\(^9\) This may provide a partial explanation of failure of our Ti\(^{201}\)MPS technique to help increase the accuracy of assessment of complications and prognosis.

In our series, EF was as much improved at discharge as reported by other investigators\(^10,11,12\). Although the number of patients was small, there were 15 patients with single coronary disease of the left anterior descending artery lesion responsible for anterior infarction. Of these patients, three had total occlusion without collateral circulation, five with collateral circulation and seven had recanalization. It is of interest to note that among these three groups there were no significant differences in Ti score and RNEF at acute stage and improvement from RNEF on admission to angiographic EF at discharge. The intracoronary administration of Urokinase for the purpose of revolving thrombi and, eventually promoting recanalization, gains popularity. It is very important to know that recanalization really contributes to the improvement of LV function which is one of the most important variables for determination of the prognosis.\(^13\) Although seven cases recanalized spontaneously in our series, it is interesting that those patients were identical in Ti score and the improvement of EF to the groups of total occlusion. It is essential to pursue this problem in large numbers of cases.

Finally, this paper does not contain data obtained in the serial Ti\(^{201}\)MPS and MGCBP studies done in order to determine the ability of serial imaging of Ti\(^{201}\) with redistribution analysis to differentiate ischemic and necrotic myocardium.\(^14\) There were 15 patients on whom initial Ti\(^{201}\)MPS was performed were followed 4–6 hours later by delayed scintigraphy. We could not demonstrate any significant redistribution in these cases. On the other hand, Zir\(^15\) performed serial Ti\(^{201}\)MPS and MGCBP studies on patients with acute myocardial infarction within 12 hours onset of chest pain and obtained the following findings. (1) Redistribution occurred in zones of acute myocardial infarction in the early hours and is presumed to be evidence of reversible ischemic component. (2) Redistribution patients had better EF than

non-redistribution patients. (3) Redistribution occurred in areas remote from the site of acute myocardial infarction was most likely related to the other severe coronary artery disease involvement. Although their report was preliminary and we have to wait for the final conclusion, the only difference between their reports and ours seems to be the timing for interventions.

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