*Radiol Oncol* 1997; 31: 286-90.

# Diagnostic value of planar myocardial perfusion scintigraphy in patients with coronary artery disease

**Marko Klančič,[1] Metka Milčinski,[1] Darko Zorman [2]**

*[1] Nuclear medicine, [2] Cardiology, University Medical Centre, Ljubljana, Slovenia*

*Patients with suspected or proven coronary artery disease are investigated using noninvasive and invasive diagnostic methods. Noninvasive myocardial perfusion scintigraphy provides data on myocardial perfusion during stress and at rest. Coronary angiography is invasive morphologic method, performed before coronary artery dilatation or surgery. Aim of our retrograde analysis of planar thallium myocardial perfusion scintigrams and coronary angiograms was to assess sensitivity and specificity of myocardial perfusion planar scanning and to evaluate causes of possible disagreement. Original readings of myocardial perfusion scans and coronary angiograms of 156 patients with coronary artery disease were compared. When results of both investigations were partially concordant or discordant, the original studies were reviewed. Concordant results of both examinations were found in 62% of patients. In only 3% (5 patients) the results were discordant and the reason for disagreement of results of both studies could not be detected. Most of the remaining 55 patients had more pronounced myocardial perfusion defects than was the estimated severity of coronary artery stenosis, attributed to the different nature of both investigations. Anomalous coronary artery was found in 3% of all patients, tortuous coronary arteries with slow flow of contrast media in 9 patients (6% of all) and arterial hypertension with extreme left ventricular wall hypertrophy in one patient. Sensitivity of the myocardial perfusion scintigraphy was 100% and specificity 50%. Positive predictive value for coronary artery disease was 96% and negative predictive value was 100 %. We cconclude that myocardial perfusion scintigraphy has a definite role in diagnosis and follow-up of patients with suspected or proven coronary artery disease. New techniques and technetium labeled tracers improve reliability of myocardial perfusion scintigraphy and enable reasonable use of more aggressive diagnostic methods.*

*Key words: coronary disease-diagnosis; heart-radionuclide imaging*

## Introduction

Various diagnostic possibilities exist for patients with suspected or proven coronary artery disease. Clinical data are combined with electrocardiogram (ECG) and stress testing.[1] Myocardial perfusion scintigraphy is significantly more accurate for diagnosing coronary artery disease than the exercise ECG.[2,3,4]

Correspondence to: doc. dr. Metka Milčinski, Nuclear medicine, University Medical Center, Zaloška 7, 1525 Ljubljana; Tel: +386 61 316 855, Fax: +386 61 132 72 72, e-mail: meta.milcinski@mf.uni-lj.si

UDC: 616.127-005.8:539.163

Additional invasive approaches are needed for evaluation of the disease extent, severity and before the therapeutic interventions. Coronary angiography detects morphological changes utilizing intracoronary injection of the contrast media.[5,6,7] Myocardial perfusion scintigraphy uses photon or positron emmitting substances to assess myocardial perfusion. Among first radiopharmaceuticals and until recently the most widely used was thallium 201.[3,4,8,9] Results of the myocardial perfusion imaging and the coronary angiography are usualy compared. Their concordance depends on the degree of coronary artery disease, previous myocardial infarction and technical factors.[3,10,11] As treatment of patients with coronary artery disease depends on the results of diagnostic tests, they have to be accurate.

Our retrograde analysis of myocardial perfusion scintigrams and coronary angiograms in patients with coronary artery disease was performed to assess sensitivity and specificity of myocardial perfusion planar scanning and to evaluate causes of possible disagreament.

## Patients and methods

Consecutive patients, referred for suspected or proven coronary artery disease to myocardial perfusion scintigraphy in two and a half years period were included. The time between perfusion scintigraphy and the coronary angiography had to be less than six months. No acute coronary event or therapeutic intervention between both examinations was allowed.

In the two and a half years' period more than 1000 patients had myocardial perfusion scintigraphy and 341 of them had coronary angiography. Only 156 of those had both investigations performed in up to 6 months period and both studies available in the archives. *Clinical data* (gender, age, previous myocardial infarction, possible fibrinolytic therapy, arterial hypertension and angina) were analysed. Left bundle branch block was searched for in ECG. Data are given in Table 1.

**Table 1.** Patients' data.

| | Number | % of all |
|---|---|---|
| Men | 133 | 85 |
| Women | 23 | 15 |
| <40 years | 2 | 1 |
| 40-50 years | 43 | 28 |
| >50-60 years | 64 | 41 |
| >60-70 years | 42 | 27 |
| >70 years | 5 | 3 |
| Time between investigations | | |
| <1month | 84 | 54 |
| 1-3months | 46 | 29 |
| 4-6months | 26 | 17 |
| Hypertension | 92 | 59 |
| Angina pectoris | | |
| Typical | 125 | 80 |
| Atypical | 26 | 16 |
| Myocardial infarction | 92 | 59 |
| Ventriculography | | |
| anterior wall hypokinesia | 87 | 56 |
| inferior wall hypokinesia | 47 | 30 |
| Collateral arteries | 77 | 49 |
| Left bundle branch block | 5 | 3 |
| Thrombolytic therapy of myocardial infarction | 24 | 15 |

*Myocardial perfusion scintigraphy* was performed using planar scintigraphy (General Electric 300 gamma camera, Macintosh II fx computer, LEAP collimator, 64 x 64 matrix, 7 minutes per view) in best septal (LAO 30 – 45 degrees), anterior and left lateral projection. Thallium (TICI – 201, 74 MBq) was injected during submaximal, simptome limited or during pharmacologic stress (dipyridamol 0,56 mg/kg body weight). Scintigrams were acquired immediately after stress (stress imaging) and three to four hours latter (rest imaging). Visual analysis of myocardial perfusion scintigrams was performed; perfusion was described as normal, diminished or absent for anteroseptal, posterobasal, apical, lateral and inferior regions in stress and rest.[2,3,10,12]

Left ventricular wall motion was observed on *contrast ventriculography* and described as normal, hypo-, a- or diskynetic for anterior or inferior wall.

Coronary artery narrowing was evaluated on *coronary angiograms* for left anterior descending artery (LAD), left circumflex artery (LCX), right coronary artery (RCA) and graded as less than 50%, 50-69%, 70-89%, 90-99% or as occluded.[5,6]

*Data comparison:* original readings of myocardial perfusion scans and coronary angiograms were compared for LAD, LCX and RCA perfusion territories. Results of comparison were either concordant (hypoperfused areas and stenosis in the same regions), partially concordant (not all areas concordant or differing degree of stenosis / tracer accumulation) or discordant (perfusion abnormality and coronary artery stenosis on different areas or not detected). When incompletely concordant and discordant results of both studies were found, original studies were reviewed by two experienced nuclear medicine specialists and the cardiologist.

*Statistical methods:* patients' data were expressed in percent and average values. Sensitivity, specificity, positive and negative predictive value for myocardial perfusion scintigraphy were calculated.[13]

## Results

Both examinations gave concordant results in 62% of patients. Only in 3% of all patients the results were discordant. In the remaining 35% concordance was only partial. Distribution of separate coronary artery narrowings is shown on Figures 1 a - c. Calculated sensitivity of the myocardial perfusion scintigraphy was 100% and specificity 50%. Positive predictive value for coronary artery disease was 96% and negative predictive value was 100 %. Specificity and sensitivity for separate perfusion areas for men and women are given in Table 2.

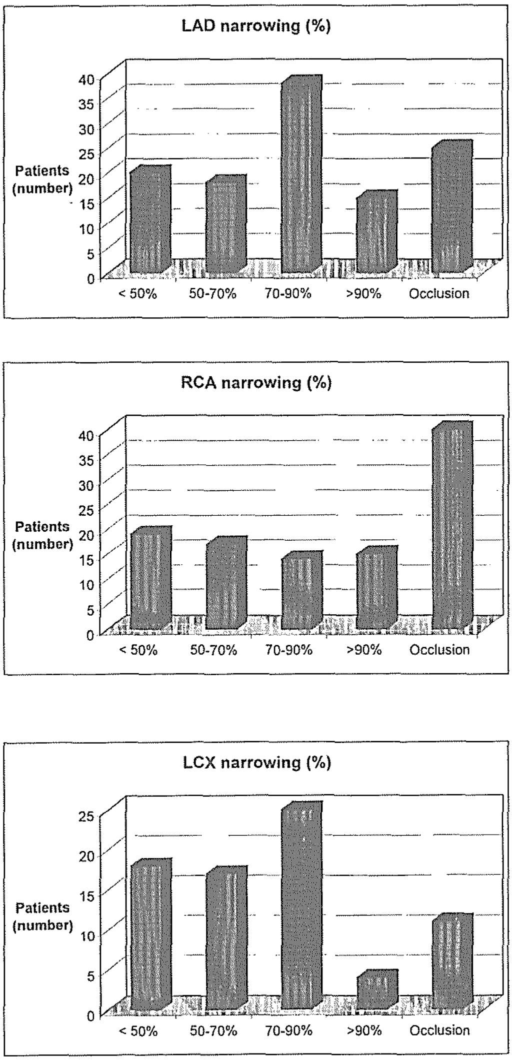


**Figure 1.** Distribution of coronary artery narrowings: a) left anterior descending artery - LAD, b) right coronary artery - RCA, c) left circumflex coronary artery - LCX.

## Discussion

Myocardial perfusion scintigraphy is a common diagnostic method in evaluation of patients with suspected or proven coronary artery disease.[2, 3, 4] Coronary angiography is the golden standard in diagnostic evaluation of patients with coronary artery di-

**Table 2.** Sensitivity and specificity of myocardial perfusion scintigraphy for separate coronary artery perfusion areas in a) men, b) women.

| 2 a: Men | Sensitivity | Specificity |
|---|---|---|
| Left anterior descending coronary artery | 96% | 61% |
| Right coronary artery | 100% | 79% |
| Left circumflex artery | 89% | 94% |

| 2 b: Women | Sensitivity | Specificity |
|---|---|---|
| Left anterior descending coronary artery | 93% | 38% |
| Right coronary artery | 89% | 100% |
| Left circumflex artery | 86% | 93% |

sease. It is a morphologic method, performed mostly in resting conditions; it has to be performed before coronary artery dilatation or surgery.[5, 6] Myocardial perfusion scintigraphy can not give anatomic details but provides data on myocardail perfusion during stress and at rest, thus detecting myocardial hypoperfusion before symptoms are evident at rest. It can therefore be used as a screening method in patients with intermediate pretest probability of coronary artery disease.[1, 4, 14, 15] Planar method was used until tomographic technique became available also at our institution. The data on sensitivity and specificity of myocardial perfusion scintigraphy vary largely and depend mostly on inclusion criteria used for separate study. The sensitivities from 79 to 96% and specificities from 85 to 91% are common; sensitivities from 20 to 80 % for separate coronary arteries in unselected patients are described.[2, 16] Evaluation of the method in separate institutions is therefore needed. Our study is a part of quality control process and helps to assess clinical impact of diagnostic procedures. Patients in our study were selected on basis of both investigations performed. Most of them had severe coronary artery disease with angina pectoris, previous myocardial infarction and wall motion abnormalities (Table 1).

"False positive" myocardial perfusion scintigrams were detected in 60 patients (38% of all) at the original first reading. The studies were reanayzed and underlying coronary pathology was detected in 55 patients. Most of them had more pronounced myocardial perfusion defects than was the estimated severity of coronary artery stenosis. This is a natural consequence of the different nature of both investigations. Other causes of "false positive" results were anomalous coronary artery in 5 patients (3% of all), tortuous coronary arteries with slow flow of contrast media in 9 patients (6% of all) and arterial hypertension with extreme left ventricular wall hypertrophy in one patient.

Anterior wall hypoperfusion due to anomalous coronary artery can be present already at rest. Extensive additional patological findings on stress scan are detected.[3, 17] An example of coronary angiogram in patient with anomalous coronary artery is shown on Figure 2. Tortuous coronary arteries with slow

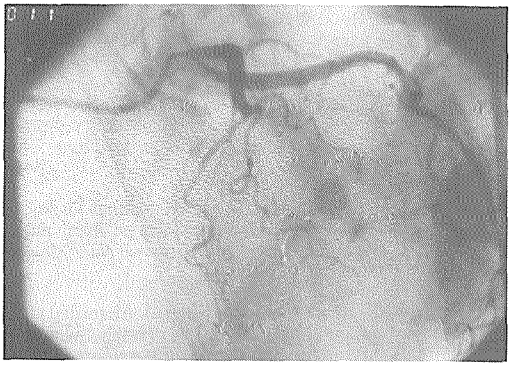

**Figure 2.** Coronary angiogram, left anterior oblique projection: anomalous left anterior descending coronary artery.

flow of contrast media cause inadequate myocardial perfusion without coronary artery stenosis.[3, 18] An example of coronary angiogram of our patient is shown on Figure 3. In patiens with arterial hyper-

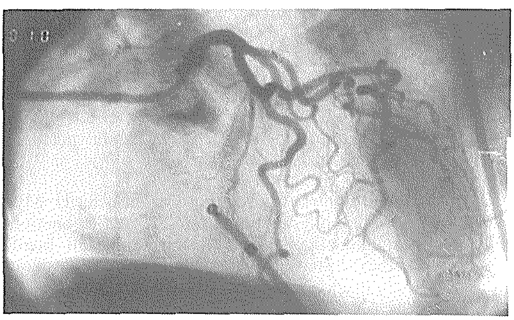

**Figure 3.** Coronary angiogram, left anterior oblique cranial projection: tortuous coronary artery.

tension, myocardial perfusion abnormalities are attributed to diminished coronary flow reserve.[19, 20] We detected evident perfusion defect in one patient with normal coronary arteries on angiography. Systolic and diastolic frames from contrast ventriculography of this patient are presented on Figure 4 (a, b); myocardial hypertophy with obliteration of myocardial cavity in systolic frame is evident.

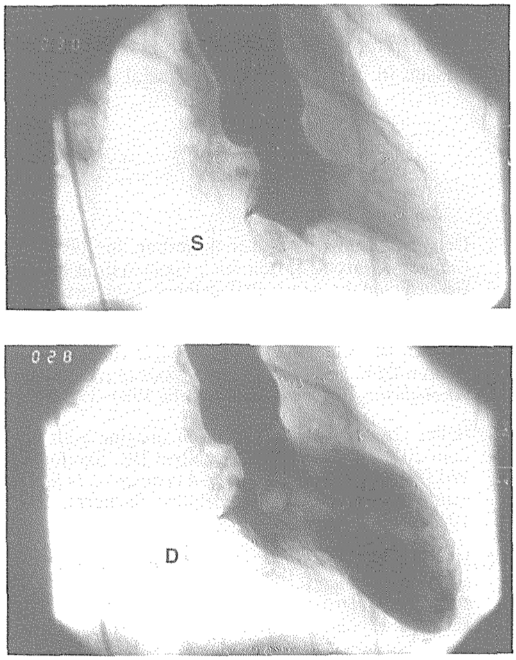


**Figure 4.** Contrast ventriculography, right anterior oblique projection: left ventricular hypertrophy. Left ventricle in a) systole, b) diastole.

False positive myocardial perfusion scans are possible in patiens with left bundle branch block.[22, 23] In 4 of our 5 patients with this conduction abnormality scintigraphic findings were concordant with angiographic findings, reflecting reliability of our nuclear medicine specialists.

The low specificity of myocardial perfusion scans for LAD perfusion territory in women can be due to the low number of women in our study and to the attenuation of thallium radioactivity in soft tissue.[8, 10, 11]

In 5 patients no evident reason for disagreement of results of both studies could be detected. Discordance could be due to the natural course of coronary artery disease[23] or episodes of silent ischaemia.[25]

In conclusion, myocardial perfusion scintigraphy has a definite role in diagnosis and follow-up of patients with suspected or proven coronary artery disease. New techniques and technetium labeled tracers improve reliability of myocardial perfusion scintigraphy and enable reasonable use of more aggressive diagnostic methods. Scintigraphy can evaluate the functional significance of coronary stenoses, detected by coronary angiography or magnetic resonance imaging. Development of positron emission tomography and positron emission tracers allows differentiation of viable myocardium and scar tissue in patients after myocardial infarction.[4]

## References


1. Detry J-MR, Fox KM. Exercise testing. In: Julian DG, Camm AJ, Fox KM, Hall RJC, Poole Wilson PA eds. *Diseases of the heart.* Philadelphia: Saunders, 1996: 372–85.
2. Holman BL. Cardiac imaging. Nuclear cardiology. In: Braunwald E. Heart disease. *A textbook of cardiovascular medicine.* Philadelphia: Saunders, 1984: 351–99.
3. Beller GA. Myocardial perfusion imaging with thallium-201. In: Marcus ML, Schelbert HR, Skorton DJ, Wolf GL eds. *Cardiac imaging. A companion to Braunwald's heart disease.* Philadelphia: Saunders, 1991: 1047-73.
4. Huggins GS, Gewirtz H. Clinical presentation and diagnostic techniques. In: Fuster V, Ross R, Topol EJ eds. *Atherosclerosis and coronary artery disease.* Philadelphia: Lippincott-Raven, 1996: 1401-18.
5. Genssini GG. Coronary arteriography. In: Braunwald E. *Heart disease. A textbook of cardiovascular medicine.* Philadelphia: Saunders, 1984: 279-303.
6. Johnson MR. Clinical aspects of data acquisition in coronary angiography. In: Marcus ML, Schelbert HR, Skorton DJ, Wolf GL eds. *Cardiac imaging. A companion to Braunwald's heart disease.* Philadelphia: Saunders, 1991: 182-210.
7. Zorman D, Milčinski M. Koronarna angiografija pri ishemični srčni bolezni. *Med Razgl* 1992; **31:** Suppl 2: 32-4.
8. Beller GA. Diagnostic accuracy of thallium-201 myocardial perfusion imaging. *Circulation* 1991; **84:** Suppl 1: I-1-I-6.
9. Kotler TS, Diamond GA. Exercise thallium-201 scintigraphy in the diagnosis and prognosis of coronary artery disease. *Ann Intern Med* 1990; **113:** 684-702.
10. Gerson MC. Myocardial perfuson imaging kinetics and planar methods. In: Gerson MC ed. *Cardiac nuclear medicine.* New York: McGraw-Hill, 1987: 1-24.
11. Hör G, Klepzig H. Myocardial scintigraphy with 201Tl: II. Clinical applications (Coronary heart disease). *Nucl Med* 1987; **26:** 155-8.
12. Wilson R, Shea M, de Landsheere I et al. Myocardial blood flow: clinical application and recent advances. In: Simoons ML, Reiber JHC eds. *Nuclear imaging in clinical cardiology.* Boston: Martinus Nijhoff, 1984: 39-59.
13. Ingelfinger JA, Mosteller F, Thibodeau LA, Ware JH. *Biostatistic in clinical medicine.* New York: Macmillan, 1986: 1-24.
14. Melin JA, Piret LJ, Vanbutsele RJM et al. Diagnostic value of exercise electrocardiography and thallium myocardial scintigraphy in patients without previous myocardial infarction: a Bayesian approach. *Circulation* 1981; **63:** 1019-24.
15. Rifkin RD, Hood WB. Bayesian analysis of electrocardiographic exercise stress testing. *N Engl J Med* 1977; **297:** 681-6.
16. Gerson MC. Test accuracy, test selection and test results interpretation in chronic coronary artery disease. In: Gerson MC ed. *Cardiac nuclear medicine.* New York: Mc Grow – Hill, 1987: 309 - 47.
17. Milčinski M, Budihna N, Klančič M, Zorman D. Anomalous coronary arteries: cause of "false positive" planar thallium myocardial perfusion scans. *J Nucl Cardiol* 1995; **2:** Suppl 2: S15 (abstr).
18. Bortone AS, Hess OM, Eberli FR et al. Abnormal coronary vasomotion during exercise in patients with normal coronary arteries and reduced coronary flow reserve. *Circulation* 1989; **79:** 516-27.
19. Depuey EG, Guertler-Krawczynska E, Perkins JV, Robbins WL, Whelchel JD, Clements SD. Alterations in myocardial thallium-201 distribution in patients with chronic systemic hypertension undergoing single-photon emission computed tomography. *Am J Cardiol* 1988; **62:** 234-8.
20. Koga Y, Yamaguchi R, Ogata M, Kihara K, Toshima H. Decreased coronary vasodilatory capacity in hypertrophic cardiomyopathy determined by split-dose thallium-dipyridamole myocardial scintigraphy. *Am J Cardiol* 1990; **65:** 1134-9.
21. Jazmati B, Sadaniantz A, Emaus SP, Heller GV. Exercise thallium-201 imaging in complete left bundle branch block and the prevalence of septal perfusion defects. *Am J Cardiol* 1991; **67:** 46-9.
22. Knapp WH, Bentrup A, Schmidt U, Ohlmeier H. Myocardial scintigraphy with thallium-201 and technetium-99m-hexakis-methoxyisobutiulisonitrile in left bundle branch block: a study in patients with and without coronary artery disease. Eur *J Nucl Med* 1993; **20:** 219-24.
23. Wajnberg A. The syndrome of angina in patients with normal or nearly normal coronary arteriograms. *CVR&R* 1992; 48-61.
24. Samman B, Hahn SD, Messinger DE, Heller GV. Spontaneus silent myocardial ischemia assessed by technetium-99m-sestamibi imaging. *J Nucl Med* 1993; **34:** 134-6.