

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

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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 conclude 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}

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 emitting 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 usually 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 coro-

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nary 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 disagreement.

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 (TlCl – 201, 74 MBq) was injected during submaximal, symptome 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 later (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 dyskynetic 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.

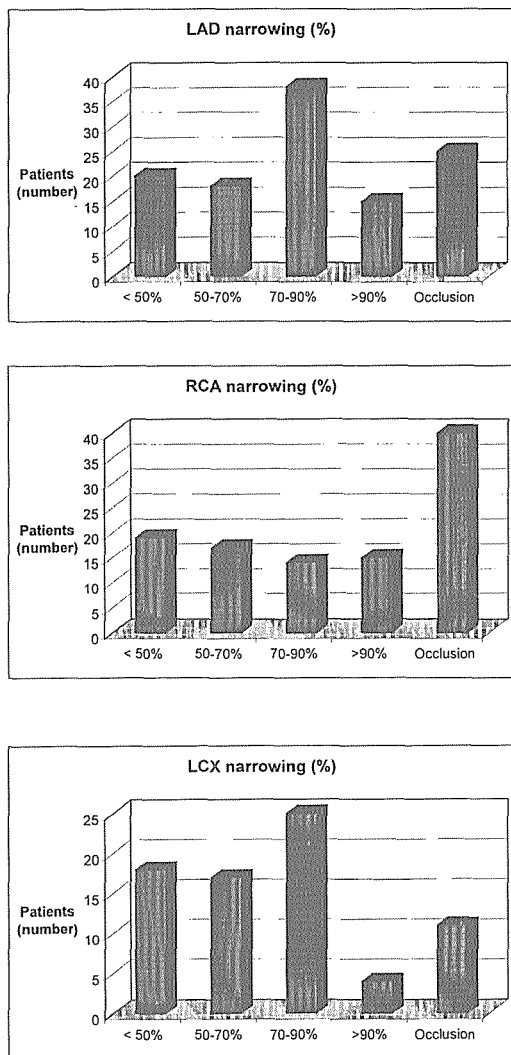


Figure 1. Distribution of coronary artery narrowings: a) left anterior descending artery - LAD, b) right coronary artery - RCA, c) left circumflex coronary artery - LCX.

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 myocardial 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 reanalyzed 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 pathological 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 patients with arterial hyper-

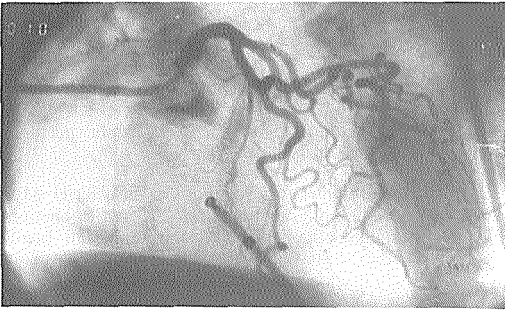


Figure 3. Coronary angiogram, left anterior oblique cranial projection: tortuous coronary artery.

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 hypertrophy with obliteration of myocardial cavity in systolic frame is evident.

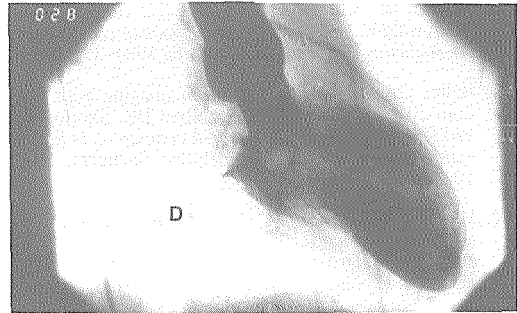
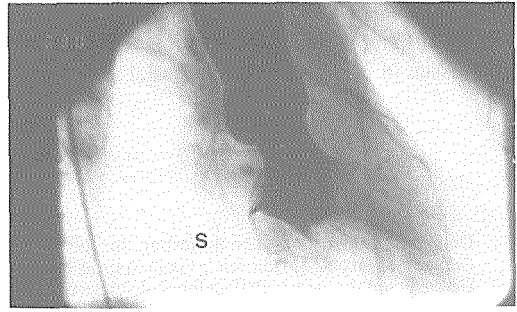


Figure 4. Contrast ventriculography, right anterior oblique projection: left ventricular hypertrophy. Left ventricle in a) systole, b) diastole.

False positive myocardial perfusion scans are possible in patients 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 disease²³ 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

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