Prognostic value of myocardial perfusion scintigraphy for patients suspected of and diagnosed with coronary artery disease

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Abstract

BACKGROUND: The prognostic value of myocardial perfusion scintigraphy (MPS) continues to attract interest and provoke discussions. This study was an attempt to investigate the methods.

OBJECTIVE: Determination of the prognostic value of MPS for patients suspected of and diagnosed with coronary artery disease (CAD).

MATERIAL AND METHODS: The study group included 215 patients, 134 males and 81 females, aged 21–66, mean age 48. Tc-99m-MIBI myocardial perfusion scintigraphy was performed and information concerning the diagnosis, aim of the examination, past coronary episodes, clinical condition, duration and type of complaints, concomitant diseases, test results, revascularisation procedures and pharmacological treatment was gathered. Further history of the patients was monitored throughout the observation period of 52 months on average.

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The patients were divided into the following two groups: Group I — suspected coronary artery disease: 124 patients aged 21–65, 59 males and 65 females; Group II — diagnosed coronary artery disease: 91 patients aged 31–66, 75 males and 16 females diagnosed with CAD, including 39 s/p myocardial infarct, 31 s/p infarct and revascularisation, 21 s/p revascularisation. The probability of CAD was calculated using the Diamond method for the patients suspected of CAD. The obtained results were examined in a statistical analysis.

RESULTS: Normal MPS results were obtained for 94/124 patients suspected of CAD, 15/91 patients diagnosed with CAD, 64/81 females and 45/134 males. In Group I, apart from pathological MPS results, reversible ischemia was determined in as many as 27/30 patients, and only 17/91 patients in Group II. No patients with normal MPS results suffered major cardiac events, only one of them underwent revascularisation. Major cardiac events occurred in the case of patients with pathological MPS results: Group I — 2 myocardial infarcts and 2 cardiac deaths, Group II — 3 infarcts and 10 cardiac deaths. Minor cardiac events, apart from one case, were also only observed in the case of patients with pathological MPS results: Group I — 10 revascularisations and one case of unstable CAD, Group II — 12 revascularisations and 7 cases of unstable CAD. Patients with normal MPS results and stenosis in coronary angioraphy suffered no cardiac events. Cardiac events occur mostly in the group with a medium and high risk of CAD and in the case of patients diagnosed with CAD.

CONCLUSIONS: 1. Normal MPS results for patients suspected of or diagnosed with CAD: s/p infarct and/or CABG prognosticate a mild course of the disease, without or with a minimal number of cardiac events, also in a longer observation period. 2. Pathological MPS results clearly imply a greater risk of cardiac events, and the number of events increases with the greater probability of CAD and with the patient's age. 3. Normal MPS

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results, even with significant stenosis in coronary angiography, prognosticate a low risk of cardiac events.

Key words: myocardial perfusion scintigraphy, prognostic value

Introduction

Usually coronary artery disease (CAD) can be diagnosed based on the results of non-invasive diagnostic methods. They help determine the coronary flow reserve, myocardial haemodynamics and possibly define patient's eligibility for an invasive diagnostic procedure, mostly coronary angioraphy. Not only are they helpful in diagnosing and choosing the best treatment, but they also have prognostic value. A prognosis means the anticipated course of disease and the prospect of specific events. In the case of CAD, myocardial infarct or cardiac death, i.e. so-called major cardiac events, revascularisation or emergence of unstable CAD, i.e. so-called minor cardiac events, are mostly taken into consideration. The applied diagnostic procedures can have a different prognostic value, also referred to as a predictive value of a test, in assessing the probability of an event.

The diagnostic procedures applied in the case of CAD patients are frequently complementary methods. The objective is to select a method or methods most appropriate in a given clinical situation. Myocardial perfusion scintigraphy (MPS) is a procedure which enables assessing the impairment of the coronary circulation. Patients with indications for MPS can be divided into several groups: patients suspected of CAD, those diagnosed with stable CAD, patients status post such cardiac events as infarct and/or revascularisation, status ante revascularisation for the assessment of myocardial viability, patients with an acute coronary episode after thrombolytic therapy. In the recent years, the prognosis and assessment of the risk of cardiac events was considered another indication for MPS [1]. The high prognostic value of MPS was confirmed in a number of papers, regardless of the applied radiopharmaceuticals and stress protocols. The risk of major cardiac events increases in proportion to the number of segments with reversible or persistent ischemia [2–4]. The aim of this paper is to determine the prognostic value of Tc-99m-MIBI MPS for patients suspected of and diagnosed with coronary artery disease.

Material and methods

The study group included 215 patients, 134 males and 81 females, aged 21–66, mean age 48 ± 9 (SD), status post myocardial perfusion scintigraphy. All the patients provided information on their further history during the observation period of 36-86 months, mean duration 52 months.

The patients were divided into the following two groups:

— Group I — suspected coronary artery disease — 124 patients aged 21–65, mean age 47 ± 10 (SD), 59 males and 65 females non-diagnosed with myocardial infarct and without any significant coronary lesions in coronary angiography; 103 patients referred for MPS to determine indications for coronary angiography, 21 patients with persistent typical coronary complaints and lack of any clinically significant coronary lesions in coronary angiography;

— Group II — diagnosed coronary artery disease — 91 patients aged 31–66, mean age 50 ± 9 (SD), 75 males and 16 females diagnosed with CAD, including 39 patients s/p myocardial infarct (determined based on typical clinical symptoms, ECG results and biochemical tests), 31 patients s/p myocardial infarct and revascularisation, 21 patients s/p revascularisation; a total of 70 patients were observed to have had an infarct: 18 patients within up to half a year, 16 patients within more than six months to one year, and 36 patients within more than one year prior to the examination. Revascularisation was performed in a total of 52 patients, in 38 within up to one year, and in 14 within more than one year prior to MPS. The above groups are characterised in Table 1.

For all the patients suspected of CAD, without infarct, revascularisation and with normal coronary angiography results, the probability of CAD was calculated using the Diamond method, i.e. based on their age, sex and type of complaints. The patients were divided according to the results into groups with a low, medium and high risk of CAD: from 0 to 0.30 — low risk, 0.31 to 0.70 — medium risk, more than 0.71 — high risk of coronary artery disease.

MPS was performed according to a two-day protocol. Scintigraphy at rest involved IV administration of 700–800 MBq of Tc-99m-MIBI, SPECT images were acquired within 40–60 minutes after the administration of the radiopharmaceutical. Stress test was performed according to the Bruce protocol, where physical stress test was combined with IV administration of dipyridamole. The physical stress test was terminated when patients achieved at least 85% of the heart rate limit or positive test features were observed. One minute prior to the anticipated termination, 700–800 MBq of Tc-99m-MIBI was administered intravenously. Post-stress SPECT images were acquired, similarly as during the test at rest, within 40–60 minutes after the administration of the radiopharmaceutical. All the examinations were registered with a Picker gamma camera, Dyna Pro SX-300. Tomographic profiles were reconstructed by back projection using first Metz filter, and then median filter. A series of images along the cardiac short axis were obtained — frontal, horizontal and sagittal images as well as two series of long-axis images.

Information about the patients' history in the defined observation period, i.e. at least 36 months after the MPS examination, was obtained retrospectively based on: questionnaire responses, hospital documentation, coronary angiography results, personal or telephone interviews, review of the whole group for deaths in the civil registry office. The questionnaire included questions about the further course of the disease, additional examinations, revascularisation procedures, medication, current complaints, hospitalisation, cardiac events. Cardiac events were divided into: "major" events, such as myocardial infarct and cardiac death, and "minor" events, such as revascularisation due to coronary complaints (CABG or PTCA) and unstable coronary artery disease (intensified coronary complaints with recurring hospitalisation periods). Cardiac death was defined as death for the major reason of suspected or diagnosed myocardial infarct, life-threatening arrhythmia, pulmonary oedema or suspected cardiac death with no other causes diagnosed. The observation period was terminated at the time of an infarct, death or revascularisation.

Table 1. Description of patients based on the interviews (n = 215)

	Group I. Suspected CAD	Group II. Diagnosed CAD	Total
Number of patients	124 (100%)	91 (100%)	215 (100%)
Male	59 (47%)	75 (82%)	134 (62%)
Female	65 (53%)	16 (18%)	81 (34%)
Age	47 ± 9 (SD)	50 ± 9 (SD)	48 ± 9 (SD)
Typical ischaemic symptoms	74 (60%)	54 (61%)	128 (59%)
Atypical ischaemic symptoms	42 (34%)	19 (20%)	61 (28%)
Duration of symptoms < 1 month	12 (10%)	5 (5%)	17 (8%)
Duration of symptom > 1 month < 1 year	48 (38%)	36 (39%)	84 (39%)
Duration of symptom > 1 year	30 (24%)	11 (12%)	41 (19%)
Coexistent diseases1	60 (49%)	55 (59%)	115 (53%)
Normal ECG result	50 (40%)	12 (13%)	62 (29%)
Abnormal ECG result2	72 (58%)	76 (85%)	148 (69%)
Normal Holter record	38 (31%)	15 (16%)	53 (25%)
Abnormal Holter record	40 (33%)	11 (12%)	51 (24%)
Normal stress test in ECG	25 (20%)	21 (22%)	46 (21%)
Abnormal stress test in ECG	56 (44%)	31 (34%)	87 (40%)
Normal rest ultrasound	82 (66%)	35 (39%)	117 (54%)
Abnormal rest ultrasound	7 (6%)	39 (42%)	46 (21%)
Pharmacological treatment3	59 (48%)	52 (57%)	111 (52%)

1 — hypertension, diabetes, hyperlipidaemia; 2 — past infarct, ischemic features, extrasystoles, repolarisation disorders, atrial fibrillation, right or left bundle branch block, Wolff--Parkinson-White syndrome (WPW); 3 — angiotensin converting enzyme inhibitors, beta-blockers, nitrates

The assessment of to what extent the specific factors have contributed to the cardiac event was carried out based on the multivariate Cox proportional hazards model. The survival analysis was based on the Kaplan-Meier test. The comparison of the survival rate in each class was based on the log-rank test. The statistical analysis was carried out with the level of significance $p < 0.05$.

Results

The involvement of one segment was observed in 27 (12%) patients, of two segments in 24 (11%) patients, of three segments in 21 (10%) patients, of four segments in 19 (9%) patients, and of more than four segments in 15 (7%) patients. Reversible ischemia of one segment was determined in 31 (14%) patients, of two segments in 27 (12%) patients, of three segments in 20 (10%) patients, and of four segments in 6 (3%) patients. Irreversible ischemia of one segment was detected in 24 (11%) patients, of two segments in 22 (10%) patients, of three segments in 11 (5%) patients, and of four segments in 5 (2%) patients. The results according to the number of segments with irreversible and reversible ischemia, and the total number of the involved segments, irrespective of the pathology, are shown in Figure 1 for Group I and in Figure 2 for Group II. Group I included a significant number of patients with reversible ischemia which can be attributed to the type of patients — these are patients suspected of coronary artery disease, without any past coronary episodes determined in the interview, prior to any revascularisation treatment. On the other hand, Group II was dominated by patients with irreversible ischemia and there were also more patients with a greater num-
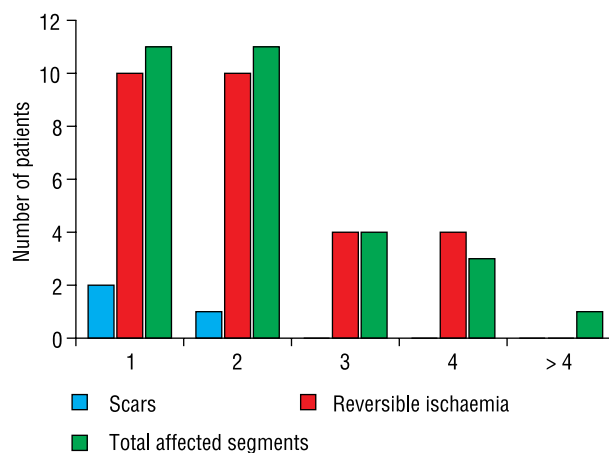

Figure 1. Number of segments with a cicatrix and/or reversible ischemia within the left-ventricular muscle in the case of patients with pathological MPS results in Group I

ber of involved segments. In Group I, there was only one patient with more than 4 segments involved, while in Group II, there were fourteen such patients.

The type of applied treatment, complaints and cardiac events reported in Group I, broken down into normal and pathological MPS results, are shown in Table 2. The average observation period for the group with normal MPS results was 58 months. In the case of the group with pathological MPS results, the observation period was shorter - only 38 months. Coronary angiography was performed for a similar number of patients in
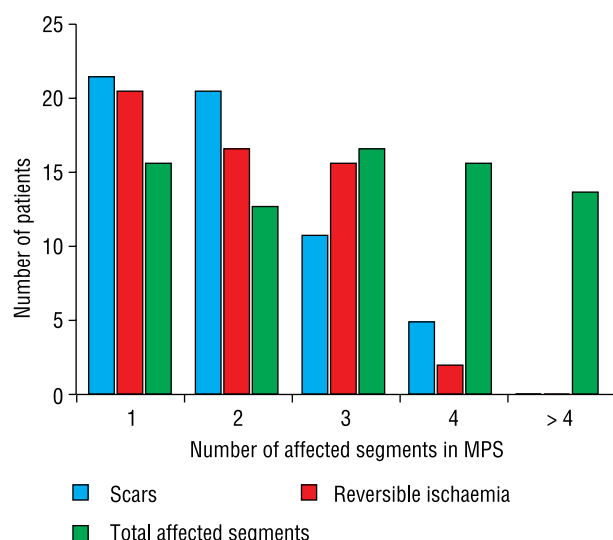
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Figure 2. Number of segments with a cicatrix and/or reversible ischemia within the left-ventricular muscle in the case of patients with pathological MPS results in Group II

both subgroups — 27/124 patients. Some patients were administered pharmacological treatment, 58 (47%) patients with normal MPS results and 20 (16%) patients with pathological MPS results. Pharmacological treatment is detailed in Table 2. 56 (45%) patients with normal MPS results and only 14 (11%)

patients with pathological MPS results reported both typical and atypical coronary complaints. Only one patient with normal MPS results was observed to suffer a revascularisation-like cardiac event. No "major" events , i.e. myocardial infarct or cardiac death, were observed. However, in the case of patients with pathological MPS results, 2 of them had myocardial infarct, 2 suffered cardiac death, 10 underwent revascularisation, and 1 had unstable coronary artery disease.

Table 3 specifies the type of applied treatment, cardiac events and complaints reported in Group II, broken down into normal and pathological MPS results. The average observation period for the group with normal MPS results was 56 months. For the group with pathological MPS results a slightly shorter (although the difference was not statistically significant) observation period of 50 months was applied. Coronary angiography was only performed in 4 patients with normal MPS results. Clinically significant coronary stenosis was observed in 18 out of 19 coronary angiography procedures performed in patients with pathological MPS results. Pharmacological treatment was applied for the majority of patients with pathological MPS results, as shown in Table 3. Even with the treatment, both typical and atypical coronary complaints were observed. Except for two patients from the group with normal MPS results, who underwent revascularisation, no other cardiac events were observed in this group. In the group with pathological MPS results, 3 patients had myocardial infarct, 10 suffered cardiac death, 12 underwent revascularisation, and 7 had unstable coronary artery disease.

Table 2. Treatment, complaints and cardiac events during the observation period in the group of patients suspected of CAD (Group I) according to MPS results Table 2. Treatment, complaints and cardiac events during the observation period in the group of patients suspected of CAD (Group I) according to MPS results

	Normal MPS	Abnormal MPS	Total
No of patients	94 (76%)	30 (24%)	124 (100%)
Time of follow up in months	58 ±14 (SD)	38 ± 26 (SD)	53± 20 (SD)
Coronarography after MPS	13 (10%)	14 (11%)	27 (22%)
Coronarography result			
Normal	12 (10%)	5 (4%)	17 (14%)
Abnormal	1 (1%)	9 (7%)	10 (7%)
Drugs	58 (47%)	20 (16%)	78 (63%)
Drugs group			
ACE inhibitors	18 (15%)	6 (5%)	24 (20%)
Beta-blockers	30 (25%)	11 (9%)	41 (34%)
Nitrates	37 (31%)	17 (14%)	54 (55%)
Symptoms	56 (45%)	14 (11%)	70 (56%)
Type of symptoms			
Typical ischaemic	26 (21%)	11 (9%)	37 (30%)
Atypical	30 (24%)	3 (2%)	33 (265)
Events in observation			
Infarct	0	2 (2%)	2 (2%)
Interventional treatement	1 (1%)	10 (8%)	11 (9%)
Instable coronary disease	0	1 (1%)	1 (1%)
Death	0	2 (2%)	2 (2%)

Table 3. Treatment, complaints and cardiac events during the observation period in the group of patients diagnosed with CAD (Group II) according to MPS results (n = 91)

	Normal MPS	Abnormal MPS	Total
No of patients	15 (16%)	76 (84%)	91 (100%)
Time of follow up in months	56 ± 17 (SD)	50 ± 22 (SD)	51± 21 (SD)
Coronarography after MPS	4 (4%)	19 (21%)	23 (25%)
Coronarography result			
Normal	2 (2%)	1 (1%)	3 (3%)
Abnormal	2 (2%)	18 (20%)	20 (22%)
Drugs	11 (12%)	65 (71%)	76 (83%)
Drugs group			
ACE inhibitors	4 (3%)	18 (14%)	22 (17%)
Beta-blockers	10 (8%)	40 (31%)	50 (39%)
Nitrates	9 (7%)	49 (38%)	48 (45%)
Symptoms	9 (10%)	48 (53%)	57 (63%)
Type of symptoms			
typical ischaemic	6 (7%)	37 (40%)	43 (47%)
Atypical	3 (3%)	11 (12%)	14 (15%)
Events in observation			
Infarct	0	3 (3%)	3 (3%)
Interventional treatement	2 (2%)	12 (13%)	14 (15%)
Instable coronary disease	0	7 (8%)	7 (8%)
Death	0	10 (11%)	10 (11%)

The group of patients who suffered major cardiac events (myocardial infarct or death) is especially interesting. This group included 4 females and 13 males. 2 female patients suffered cardiac death and 2 myocardial infarct. Both female patients were 36 and 41 years old respectively at the time of death. One of them died within 2 months after MPS due to complications in the post-revascularisation perioperative period, and the other one within 32 months after MPS. Concomitant diseases, such as diabetes and/or arterial hypertension, were determined in 10 patients. Four patients reported no complaints, the other patients had coronary or atypical complaints. Indications for MPS were diverse: post-CABG follow-up examination in the case of 3 patients, post-CABG and post-myocardial infarct follow-up examination — 4 patients, post-infarct follow-up examination — 6 patients, post-coronary angiography follow-up examination — 2 patients, and pre-coronary angiography examination — 2 patients. It should be pointed out that as a result of MPS 8 patients were found to suffer from reversible ischemia, 7 patients were found to have a cicatrix and related reversible ischemia, and 2 patients — a cicatrix within the left-ventricular muscle. In the case of these patients the number of segments involved was 3 or more.

For patients from Group I, i.e. patients suspected of CAD, without documented coronary episodes, the probability of CAD was calculated using the Diamond method at the interview stage. Figure 3 shows the occurrence of cardiac events for the groups of patients with a low risk of CAD from 0 to 30%, a medium risk from 31 to 70% and a high risk from 71 to 99%. These groups were also divided according to normal and pathological MPS results. The risk level for patients from Group II, i.e. patients diagnosed
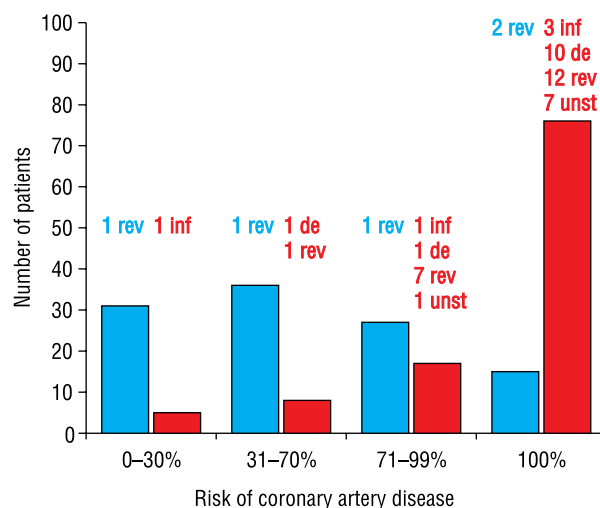

Figure 3. Number of patients and number of specific cardiac events in the groups with a low, medium and high risk of CAD according to MPS results; rev — revascularisation, inf — myocardial infarct, de — death, unst — unstable CAD, 100% probability — patients diagnosed with CAD

with CAD, was defined as 100%. As shown in the figure, cardiac events occur mostly in the groups with a medium and high risk of CAD and in the group of patients diagnosed with CAD. Apart from one revascularisation, they were observed in the case of patients with pathological MPS results. Infarcts and deaths occurred relatively evenly during the entire observation period, while
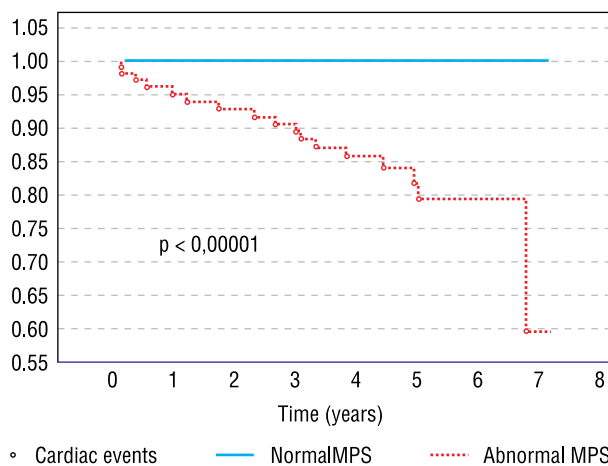
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Figure 4. Survival curves for cardiac events (infarct, death) in the case of patients with normal and pathological MPS results

revascularisation was mainly performed within one year after MPS and in the fifth year of the observation period.

The Kaplan-Meier no-event survival curves for the group of patients s/p major cardiac events are shown in Figure 4. No major cardiac events were recorded in the case of patients with normal MPS results as opposed to patients with pathological MPS results.

The factors that are to a statistically significant extent correlated with the occurrence of any cardiac events in the case of the observed patients are shown in Table 4. The greatest statistical correlation was observed between sex, MPS results, number of the involved segments in MPS, number of ischemic segments in MPS ($p < 0.001$).

Discussion

The initial probability of coronary artery disease can play an important role when selecting the benchmark diagnostic procedure or treatment and also when interpreting diagnostic test results. The initial probability can be so high that positive test results will contribute little diagnostic information, and there will be a risk of falsely

negative results. Therefore patients with a strong initial probability of CAD are directly referred for coronary angiography. In the case of patients without risk factors, and a low initial probability of CAD, negative test results are of little diagnostic value, and there is a risk of falsely positive results. The attempts at clinical classification of patients suspected of CAD in order to apply appropriate treatment are not sufficiently good. The classification into CAD risk groups introduced by Diamond is based on simple data concerning the patient's age, sex and type of complaints [6]. A more complex version, suggested by Pryor, takes into consideration other risk factors: past coronary episodes, diabetes, hypertension, smoking, family history of coronary artery disease. The greater the number of risk factors, the greater the probability of CAD [7].

In the recent literature, some authors [2, 3, 5] have discussed the current role of diagnostic test in assessing the prognosis of cardiac events. For a prognostic test to be useful, it must be highly specific, it should minimise the number of falsely positive results, which are rather frequent when prognostic tests are applied to a healthy population, it must be adequately sensitive so that negative results exclude the probability of an event to the greatest possible extent, it must be non-invasive, not too expensive and generally available; it must offer information not obtainable based on any other procedures. It should identify a pathological process at the initial reversible stage so as to enable applying appropriate treatment to prevent any adverse consequences for patients.

Among many procedures, myocardial perfusion scintigraphy is widely used for assessing prognosis. To date, Tl-201 MPS was the most widely applied method [8–10]. The first reports concerning the assessment of the prognostic value of Tc-99m-MIBI MPS date back to 1994 [11, 12]. Brown and Stratmann published articles on the usability of Tc-99m-MIBI MPS in assessing prognosis. Brown et al. carried out planar MPS with stress induced by physical exercise or dipyridamole in patients suspected of or diagnosed with coronary artery disease, and then monitored the history of patients with normal results over a post-examination period of 10 months on average. They showed that only one patient out of 234 had myocardial infarct in the observation period. Stratmann et al. published a study in which they estimated the

Table 4. Factors to a statistically significant extent correlated with any cardiac events in (infarct, death, revascularisation, unstable CAD)

Factors	Patients with cardiac events n = 50	Patients without cardiac events n = 165
Final distolic blood pressure**	86 ±13 (SD)	80 ± 13 (SD)
Final heart rate*	120 ±22 (SD)	128 ±22 (SD)
Sex***	43 M / 7 F	91 M / 74 F
History of infarct*	23 (46%)	35 (21%)
Syptoms*	36 (72%)	89 (54%)
Revascularisation**	19 (38%)	33 (20%)
Positive coronarography**	15 (30%)	25 (15%)
Positive stress test before MPS*	27 (54%)	63 (38%)
Positive MPS***	47 (94%)	59 (36%)
Number of afected segments in MPS***	147/450 (33%)	112/1485 (8%)
Number of segments with reversible ischaemia in MPS***	107/450 (24%)	62/1485 (4%)

Statistical signify: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

value of Tc-99m-MIBI MPS with dipyridamole stress in assessing the prognosis of cardiac events (infarct, death) in patients referred for the examination on account of stable CAD. 355 patients out of 534 had pathological MPS results. They showed that pathological MPS results (including both a cicatrix and reversible ischemia) are associated with a higher probability of cardiac events. Within an observation period of 13 months, 44 patients died, 14 had an infarct, in total 11% of the study population, including 2% of patients with normal MPS results and 9% with pathological MPS results.

Miller et al. presented their experiences related to SPECT Tc-99m-MIBI MPS with pharmacological stress in assessing prognosis for patients with recent uncomplicated myocardial infarct or unstable CAD prior to their discharge from hospital. Based on a year-long observation period it was shown that patients with pathological MPS results had much worse prognosis compared to those with normal results [13].

In a number of studies it was confirmed that as in Tl-201 MPS, normal results of Tc-99m-MIBI MPS suggested a low risk of cardiac events, while pathological results — a significantly greater risk thereof. In the case of normal results, the average number of events per year is about 1% or less, while in the case of pathological results — about 3-10%. Also the data obtained in the course of this study support this conclusion. 109 patients with normal MPS results had no major cardiac events in the observation period, while 17 major cardiac events (5 myocardial infarcts and 12 cardiac deaths) occurred in the group of 106 patients with pathological MPS results, i.e. 4% on average per year. This study has an important advantage over the previous works on account of a very long observation period of 52 months on average and 86 months at maximum. Even with such long observation period, no events were observed in the case of patients with initially normal MPS results, although it could have been assumed that CAD would progress.

It was shown [14–16] that normal MPS results, despite the significant stenosis determined in coronary angiography, are related to a very good prognosis. It could suggest that MPS gives a better overall functional assessment of myocardial blood supply compared to coronary angiography. In the study of Brown et al., only one patient had a major cardiac event, and 2 patients underwent revascularisation in the observation period (CABG and PTCA) within 8 and 10 months after MPS due to recurring coronary complaints out of 47 patients with normal MPS results and clinically significant stenosis (> 50% of the vessel diameter) as determined in coronary angiography, including stenosis of coronary vessels in 30 patients. The annual incidence of cardiac events in the group of patients with normal MPS results was < 1%. The disadvantage of the study referred to above is a relatively short observation period and the application of planar MPS. These disadvantages were eliminated by Soman et al., who observed 21 patients with normal coronary angiography results and Tc-99m-MIBI SPECT MPS (on average) for 30 months; one death and 5 cases of revascularisation were reported in this period [16]. This study was based on SPECT procedure, and the observation period was to a significant extent longer compared to that applied in the above-mentioned studies. 7 patients with clinically significant stenosis as determined in coronary angiography had normal MPS results; in a relatively

long observation period of more than 52 months, no major cardiac events occurred; and 2 patients underwent revascularisation.

The meta-analysis carried out by Iskander et al. [17] which included a total of 12 360 patients, both males and females, with stable CAD showed that patients with pathological MPS results carry the risk of cardiac events at 7.4% per year which corresponds to the obtained results. In accordance with the world medical literature it was shown that the risk of cardiac events grows in proportion to the area of impaired perfusion. Amanullah pointed out that the assessment of the vascular regions where perfusion is impaired contributes to the prognostic value of MPS [18] which is substantially compatible with our results.

As any other study, also this one is subject to some limitations. One of them is the small number of patients in each study group. But at the same time these are diverse groups, created based on day-to-day clinical practice, with patients who underwent SPECT MPS and were analysed according to normal and pathological MPS results . A number of patients with pathological results underwent no revascularisation or even coronary angiography, thus it can be considered an assessment of the natural course of the disease. Kamianek et al. suggested that it would be useful to include an additional parameter, such as pulmonary uptake [19]. No such parameters were analysed in this study. The currently used diagnostic standard in most centres is SPECT-based ECG-gated MPS (GatedSPECT) as it enables assessing the ejection fraction of the left ventricle and segmental disorders of myocardial contractility. The knowledge of these data increases the sensitivity and specificity of the method, and thus the prognostic value of the examination [20]. At the time of the study commencement, our centre had no GSPECT equipment.

Numerous authors confirmed the strong prognostic value of MPS, however, a significant majority of the available studies were related to populations of both females and males, frequently with a higher percentage of males in the study groups. The studies designed and conducted selectively on a female population suggest a higher prognostic value of myocardial perfusion scintigraphy, however, they are much less numerous and still under investigation [21, 22]. The problem of sex-dependent prognostic value of MPS is of interest to the authors of this paper, however, it would require a separate study due to its scope.

Conclusions

1. Normal results of myocardial perfusion scintigraphy performed under stress induced with physical exercise and dipyridamole in a group of patients suspected of or diagnosed with coronary artery disease: s/p myocardial infarct and/or CABG, contribute to the prognosis of a mild course of the disease without or with a minimal number of cardiac events, also within a longer observation period.
2. Pathological MPS results clearly imply a greater risk of cardiac events; at the same time the number of events increases with the greater probability of CAD and with the patient's age.
3. Normal MPS results, even with significant changes determined in coronary angiography (coronary stenosis), imply a very low risk of cardiac events.

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