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Short communications

Pretest clinical diagnosis of coronary artery disease and stress myocardial perfusion scintigram

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Abstract

BACKGROUND: To assess the probability of perfusion defects at exercise stress myocardial perfusion SPECT scintigraphy from pretest clinical diagnosis (medical personal history, previous ergometric investigation). To determine the value of clinical factors for probability of scintigraphic defects with respect to avoiding unnecessary investigation in subjects with low probability of abnormal scintigrams.

MATERIAL AND METHODS: 2143 subjects (1235 men, 908 women) were investigated by SPECT perfusion scintigraphy at stepwise increasing exercise stress. They were divided into three groups with regard to their medical history and exercise test at scintigraphy: subjects without any signs of coronary artery disease (CAD), patients with high likelihood of CAD (i.e., typical anginal pain, in particular at stress, positive stress ECG changes, angiographically documented important CAD) and patients after myocardial infarction (MI). Important risk factors (hypertension, diabetes, age and sex), as well as the role of revascularisation procedures, were taken into account for multiple logistic regression in order to express their importance for the odds of scintigraphic defect visualisation.

RESULTS: Perfusion scintigraphic defects (PSD) were found in 5.2% of subjects without signs of CAD, in contrast to patients with manifest CAD (68.8% with PSD) and in those after MI (90.2% with PSD). There were other important factors corroborating the likelihood of PSD (in decreasing order of importance): diabetes, male, ECG changes at stress, increasing age. Successful revascularisation improved scintigraphic images.

CONCLUSION: The examination of CAD symptom-free subjects, in particular with atypical chest discomfort, is useless. SMPS in patients after documented MI is to be carried out for other intended purposes, not for CAD diagnosis only. SMPS is highly recommended in patients with CAD symptoms and high CAD probability in order to decide further treatment and prognosis.

Key words: coronary artery disease, SPECT, perfusion scintigraphy, probability

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Introduction

SPECT stress myocardial perfusion scintigraphy (SMPS) has been widely used as an important non-invasive procedure for diagnosis of coronary artery disease (CAD). However, the price of SMPS is not negligible; it is represented by the sum of the radiopharmaceutical price, the salary of staff members and the machine time of the SPECT gamma camera. The price of myocardial perfusion imaging alone was estimated in four great European countries to be approximately Ł220 [1]. Based on the cost-effectiveness relation, SMPS must be carefully indicated in order to obtain important data that are essential for patient's treatment and prognosis. No doubt selection of patients for SMPS could be made very effectively by an experienced clinician from medical history and previous exercise testing.

The aim of this article was to check the value of pretest clinical data (patient's medical history, result of exercise test) for an estimation of the occurrence rate of perfusion scintigraphic defects (PSD) in SMPS. The main reason for our study was to improve the indication for SMPS in order to avoid unnecessary investigations in subjects with low probability of PSD and to economise this type of non-invasive diagnostic method for patients with high probability of important CAD.

Material and methods

Patients. 2143 patients (1235 men, 908 women), mean age 59.2 ± 19.1 (STD) years, considered by a clinician to have CAD, were investigated by SMPS.

Medical history. The course of the disease was described by a clinician with special regard to the attacks of anginal pain (AP), previous myocardial infarction (MI), revascularisation procedures, performed exercise stress test, hypertension and diabetes. The patients were classified according to their medical history into three groups: CAD unlikely (subjects free of any typical symptom), CAD clinically manifest (typical symptoms of AP of different intensity, documented CAD by angiography) and CAD with previous MI.

Exercise at SMPS. All patients exercised on bicycle ergometer (Ergo-line 900, The Netherlands) in semi-supine position. They started at 50 W and the load was step-wise increased every minute for 25 W. Heart frequency, blood pressure and precordial ECG were automatically registered. In accordance with common usage, the radiopharmaceutical was injected either one minute prior to the end of maximal reached load, or immediately at the end of exercise, stopped either for increasing chest pain or other circumstances [2].

SMPS exercise evaluation. The occurrence of anginal pain was monitored within the stress exercise and a horizontal or decreasing ST depression in precordial ECG records greater than 0.1 mV was taken into account.

Injected radiopharmaceuticals. Predominantly (in 1235 patients. i.e. 64.4%) 550 MBq of ^{99m}Tc-SestaMIBI (Cardiolite, Dupont, USA or Cardiospect, FJC Institute, Hungary) were injected; in the minority of patients we used either 550 MBq of ^{99m}Tc-tetrofosmin (Myoview, Amersham, UK, in 391 patients, i.e. 18.3%) or 74 MBq of ^{201}Tl-thalium chloride (Mallinckrodt, Germany, 372 patients, 17.3%). The choice of used radiopharmaceutical was made at random.

SPECT scintigraphy. Scintigraphy was carried out on dual-head gamma camera DST-XL (SMV, France) and scintigrams were processed by Vision POWER-station 4.0 programs. The criteria for PSD presence were the same for the whole study, irrespective of the radiopharmaceuticals used, i.e. an accumulation defect evident in three-dimensional images, circumferential profiles as well as in polar maps; only defects evaluated by the processing program as statistically significant were taken into account.

Statistical evaluation. Data were examined by multiple logistic regression with stepwise algorithm, when the presence or absence of PSD (dependent variable) was tested against sex, age, clinical diagnosis (CAD unlikely, CAD clinically manifest or MI in medical history), positive ECG changes at SMPS exercise, diabetes and hypertension (independent variables). Their significance was evaluated by means of F-test and their probability according to χ^2 test.

Results

The mean maximal load (± STD) at SMPS exercise was 136.7 W ± 29.1. At least 3/4 of prescribed aerobic capacity (according to sex and age) was reached at this load in the great majority of examined subjects. However exercise testing was stopped early due to AP in 249 patients; a small number of patients were unable to increase substantially the load for lower extremity weakness.

1114 persons were without any definite signs of CAD (no or non-anginal chest pain and negative stress test even in medical history). 562 patients revealed clinically manifest CAD symptoms (typical AP, positive stress test, or documented CAD by former angiography) and 467 patients were after MI.

1056 subjects of the first group without CAD signs (94.8%) had normal scintigraphic finding, whereas PSD was observed in 58 only (5.2%, PSD predominantly of a small size, without any sex prevalence). The incidence of PSD in the group of patients with clinically manifest CAD was found in 387 patients (68.8%) and PSD was absent in 175 patients (31.2%). The clinical diagnosis of MI was predominantly connected with pathologic SMPS scintigrams; marked PSD were in 424/467 patients with history of MI (90.8%) and only 43 patients (9.2%) had SMPS free of PSD.

Special attention was paid to the non-anginal chest pain in subjects without definite evidence of CAD. This symptom, in fact predominantly neurocirculatory asthenia and often of spondylarthrotic origin, was the reason for SMPS investigation in 300 female and 154 male subjects. However PSD were found in 5.7% (17/300) of women and in 25.3% (39/154) of men with this disorder. Non-anginal chest pain, sometimes called atypical chest pain, is a therefore moderately weak predictor of positive SMPS results in men without other evidence of CAD, and a very weak one in women.

79 patients without previous MI history had a horizontal or decreasing ST segment depression more than 0.1 mV in ECG at SMPS stress exercise. This finding alone had a certain significance for PSD existence but the magnitude of depression did not play any important role in predicting the occurrence of PSD (Fig. 1).

On the basis of multiple logistic regression some factors from medical history and exercise stress at SMPS were estimated to be significant for PSD prediction. Our system of statistical evaluation enabled the construction of a point scale and a list of pretest factors important for PSD presence, with an assigned number of points according to their significance (Table 1). The data of personal history revealed the highest likelihood for finding PSD, classifying the patients with great probability in those with or without clinical diagnosis of CAD. Further on, the probability of PSD was significantly influenced by diabetes and sex (men), less by stress

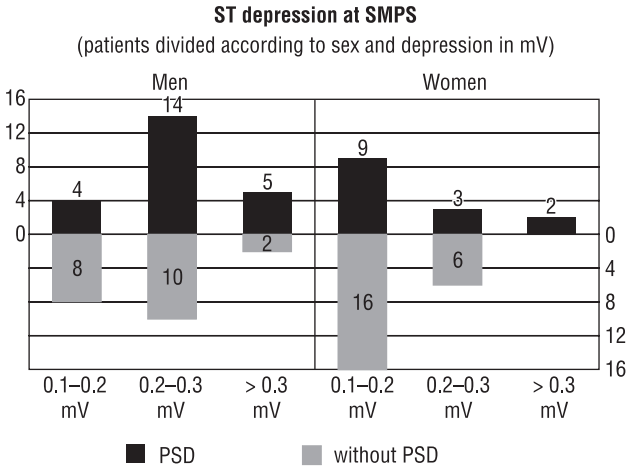

Figure 1. The distribution of horizontal or descending ST segment depression greater than 0.1 mV in precordial ECG leads observed in 79 subjects without previous MI history (43 men, 36 women) at SMPS exercise. There was neither prevalence of ST changes in 37 patients with PSD (23 men, 14 women), as compared with 42 without PSD (20 men, 22 women), nor any correlation between the magnitude of ST depression and PSD.

Table 1. Clinical factors significant for PSD finding determined by multiple logistic regression. Assigned point number expresses the importance in decreasing order. Note the influence of previous revascularisation for decreasing odds to find PSD at SMPS

Factors affecting PSD presence	Points
Previous MI	55.3
" + revascularisation	43.1
Manifest CAD	37.3
" + revascularisation	29.0
Diabetes	9.7
Males	9.2
ST depression at stress	6.3
Age: >70 y.	2.4
61–70 y.	1.6
51–60 y.	0.8
Age < 50 y.; females; without diabetes; normal stress ECG; without CAD symptoms	0.0

ECG changes and age, but not by hypertension. Previous revascularisation in verified CAD improved the scintigraphic image. The points of significant factors and the sum of their combination resulted in a score that was used for the construction of a diagram determining the probability of scintigrams with PSD, strongly corroborating the diagnosis of important CAD (Fig. 2).

Discussion

SMPS is one of the few fundamental non-invasive methods recommended for probability assessment of clinical diagnosis of CAD [3]. It was demonstrated in asymptomatic aircrew members that normal SMPS ruled out the presence of significant CAD [4]. The indication for SMPS seems to be abundantly used, predominantly by general practitioners, but by cardiologists too [5]. The selection for SMPS is usually made on the basis of careful medical history and stress test; however there are important differences in the relevance of these pretest data.

According to our results the strongest indicator for the appearance of PSD is the unambiguous evidence of healed transmural MI; a normal scintigram speaks in fact in favour of false positive clinical diagnosis of transmural MI in the past. SMPS has a value in these patients only for other specified reasons (the presence and worsening of AP, suspicion of a new lesion of another coronary artery, myocardial viability before intended revascularisation). Further on, our results are in agreement with the likelihood of significant CAD using additional variables, such as sex, age, diabetes and typical AP [6]. The ST depression was seldom connected with PSD in the minority of patients without previous MI; also we did not see any relationship between the incidence of PSD and the range of ST depression, either in males or females. It is known that the prediction of ST depression alone is low for the diagnosis of significant CAD [7, 8] and we can add that ST segment depression at stress test is not a strong predictor for the presence of PSD at SMPS.

The frequently mentioned information of non-anginal or atypical chest pain is a common reason for SMPS, in particular in females. However an abnormal scintigram in those subjects was very rare. This fact is quite in agreement with the low probability of significant CAD in population with atypical chest pain [6] that does not increase CAD risk [9]. The atypical and non-anginal chest pain alone, in particular in young women, is not any indication for SMPS.

There remains a question whether SMPS could be a suitable method for silent ischaemia disclosure in asymptomatic population. Silent ischaemia is very exceptional in the common population and even abnormal scintigrams in symptom-free subjects are

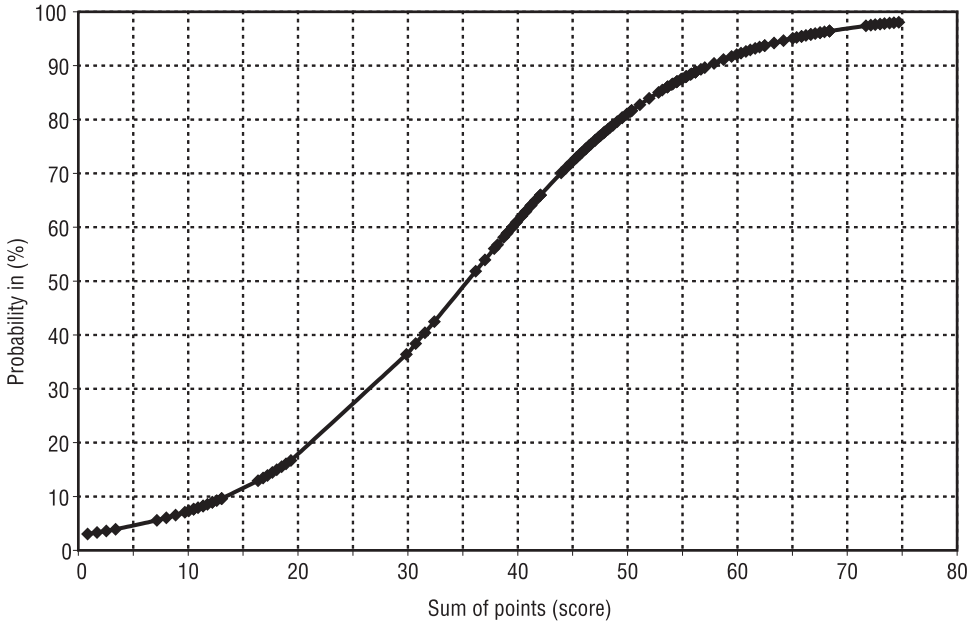

Figure 2. A diagram of PSD probability constructed by means of logistic regression. The diagram enables us to evaluate the probability of PSD finding by the sum of points of pretest clinical factors mentioned in Table 1.

often false-positive [10]. Therefore we feel that the indication for SMPS as a screening method in asymptomatic and CAD risk factor free population is not justified.

The patients undergoing SMPS investigation could be principally divided into three groups with respect to the usefulness and benefit of SMPS. Subjects without risk factors, in particular young and premenopausal women with non-anginal chest discomfort and without serious diabetes, represent the first group with very low probability of CAD; SMPS in these subjects is therefore useless. On the other hand patients with sure evidence of serious CAD (above all after transmural MI) do not need the certification of CAD existence only and they might be investigated for some other above-mentioned special purposes. There remains a third group of patients with a pretest 25%-85% probability (Fig. 2) of positive PSD finding suffering from typical AP, frequently connected with other risk factors (in particular diabetes). SMPS is fully indicated in these patients as an important non-invasive test for confirmation of CAD (its extent, possible myocardial viability and prognosis) and for decision of further therapy. These patients might also be repeatedly investigated by SMPS after successful revascularisation in order to evaluate objectively the potential improvement after the revascularisation procedure. We presume that this group of patients has the greatest benefit from SMPS and they have to be preferentially investigated.

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