



ISSN: 0975-766X

CODEN: IJPTFI

Research Article

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## MAIN METHOD OF DIAGNOSIS OF SILENT MYOCARDIAL ISCHEMIA

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Received on 14-08-2016

Accepted on 20-09-2016

### Abstract

The presence of "silent" myocardial ischemia is an unfavorable prognostic factor increasing the risk of coronarogenic complications by 2-19 times, the risk of sudden death by 3-9 times. Early and timely diagnosis of ischemic heart disease is a strategic objective, and a clinical, social and economic problem.

The analysis of recent publications devoted to the diagnosis of SMI was conducted.

The SMI diagnosis is based on various instrumental methods of research that can objectify the presence of myocardial ischemia. The most common and available SMI diagnostic techniques are electrocardiographic methods. SMI can be rarely detected with standard ECG at rest, more often - with Holter ECG, one can identify the number of SMI episodes and their duration, draw parallels with the nature of the patient's activity during the day, conduct the analysis of ischemic episodes circadian variability, and their correlation with the heart rate and ectopic activity. In case of insufficient data of ECG at rest and Holter ECG, the exercise tests are performed: exercise stress test (EST), treadmill test. Cardioselective test with transesophageal atrial electrical stimulation (TEES), excluding a number of peripheral factors, in which the imposition of artificial frequent heart rhythm causes an increase in myocardial oxygen demand. The assessment of coronary flow reserve, myocardial perfusion can be conducted with the use of coronary angiography (CAG), perfusion tomosintigraphy (method of single photon emission computed tomography), and electron beam computed tomography. There is a direct correlation between the presence of the SMI phenomenon and detection of stenosis of coronary arteries (CA). A multislice computed tomography (MSCT) - coronary angiography is

a noninvasive technique for evaluation of the CA state, which allows identifying pathological changes and clarifying the indications for the choice of preventive or treatment method for coronary heart disease.

The local myocardial contractility is determined with: echocardiography (ECHOCS), stress-ECHOCS, stress-ECHOCS with tissue Doppler imaging, and the radiopaque or radionuclide ventriculography.

Heart imaging with the help of magnetic-resonance imaging (MRI) provides a detailed assessment of structural features of the cardiac and vascular chambers, allows investigating the intracardiac hemodynamics, functional performance of the heart, measuring the velocity of blood flow in large vessels. In most cases, cardiac MRI can serve as a method of a second-line diagnosis upon obscure results of other methods of research (especially ECHOCS).

Knowing the basic methods of diagnosis allows identifying patients with SMI and starting early treatment, preventing thereby the adverse outcome.

**Keywords:** silent myocardial ischemia, diagnosis, electrocardiography, coronary angiography.

**Introduction.** Among all forms of ischemic heart disease, silent myocardial ischemia (SMI) ("quiet", "dumb") takes a special place. SMI is a common phenomenon, which occurs in 2-57% of the population, and in 15-20% of healthy individuals with IHD risk factors. The presence of "silent" myocardial ischemia is an unfavorable prognostic factor increasing the risk of coronarogenic complications by 2-19 times, the risk of sudden death by 3-9 times. Early and timely diagnosis of ischemic heart disease is a strategic objective, and a clinical, social and economic problem.

**Methods.** The analysis of recent publications devoted to the diagnosis of SMI was conducted.

**Results.** The SMI diagnosis is based on various instrumental methods of research that can objectify the presence of myocardial ischemia [1-6].

The most common and available SMI diagnostic techniques are electrocardiographic methods. SMI can be rarely detected with standard ECG at rest, but more often - with Holter ECG, in a familiar to patient physical and emotional atmosphere [3]. Holter ECG can identify the number of SMI episodes and their duration, draw parallels with the nature of the patient's activity during the day, conduct the analysis of ischemic episodes circadian variability, and their correlation with the heart rate and ectopic activity. The absence of contraindications to the use, the availability and high information value allow widely using Holter ECG for diagnosis of SMI and evaluation of the effectiveness of therapeutic activities [4]. In case of insufficient data of ECG at rest and Holter ECG, the exercise tests are performed: exercise stress test (EST), treadmill test [7]. It is believed that the occurrence of "silent" ischemia during these tests in patients with ischemic heart disease is not only of a high diagnostic value, but also indicates an

increased risk of adverse outcome. Cardioselective test with transesophageal atrial electrical stimulation (TEES), excluding a number of peripheral factors, in which the imposition of artificial frequent heart rhythm causes an increase in myocardial oxygen demand. TEES is usually recommended for exclusion of false negative (or false positive) results of stress tests. Less commonly, the pharmacological provocative tests with dobutamine, dipyridamole, adenosine, cold test, psycho-emotional stress test are used as a provoking agent [2, 4].

The assessment of coronary flow reserve, myocardial perfusion can be conducted with the use of coronary angiography (CAG), perfusion tomoscintigraphy (method of single photon emission computed tomography), and electron beam computed tomography. There is a direct correlation between the presence of the SMI phenomenon and detection of stenosis of coronary arteries (CA). The number of episodes of silent myocardial ischemia in patients with angina depends on both the number of affected CA, and the severity of CA lesion, while the number of registered SMI episodes in patients with SMI largely depends not on the number of affected CA, but on the degree of CA lesion severity [8]. The methods of radionuclear diagnostics with perfusion radiopharmaceuticals have an indisputable priority in the diagnosis of microvascular IHD. Depending on the isotope characteristics, two major myocardial imaging methods are applied: a single photon emission computed tomography (SPECT; short-lived isotopes used), and a positron emission tomography (PET; ultra-short-lived isotopes used). Perfusion tomoscintigraphy (SPECT) is the "gold" standard for the evaluation of transient myocardial ischemia. SPECT method makes it possible not only to assess myocardial blood flow at the micro-level, but also to determine the extent of damage to the cardiomyocytes. Informational value of the method increases upon combination with physical exercises, pharmacological tests (dipyridamole, sodium adenosine triphosphate) [9]. During the perfusion tomoscintigraphy, the tissues with normal coronary blood flow accumulate radiopharmaceuticals (isotopes of Thallium-201, Technetium-isonitrile compounds, Tetrofosmin, etc.) quite uniformly, while in myocardial ischemia, including its silent form, the decreased accumulation zones – perfusion defects – occur [10-14]. Currently, nuclear cardiology has a high-tech method for assessment of myocardial perfusion reserve such as PET. Using the positron perfusion agents (ammonium-13N;  $^{15}\text{O}$  labeled water) makes possible not only to determine the depth and area of myocardial perfusion defect, but also to absolutely measure the coronary blood flow (in milliliters per minute per gram of tissue). The disadvantage of this method is its high cost, so it cannot be recommended for widespread use [10, 15, 16].

Detection and quantitative analysis of the severity of coronary calcification has become one of the main trends of practical application of electron beam tomography (EBT). The high correlation has been recorded between coronary

calcifications identified with EBT: with the severity of coronary lesions according to coronary angiography; with data of intracoronary ultrasound; with the volume of histologically identified atherosclerotic plaques; with the number of coronary heart disease risk factors; and with the number of cardio-vascular events [17,18]. A multislicecomputed tomography (MSCT) - coronary angiography can be used for screening of coronary calcium, and the direct comparison of the calcium index level calculated with MSCT and EBTshows a high correlation between the data of these methods. MSCT-coronary angiography is a noninvasive technique for evaluation of the CA state, which allows identifying pathological changes and clarifying the indications for the choice of method for the prevention or treatment of coronary heart disease. The possibility of MSCT to evaluate coronary arteries throughout their sufficient length and the compliance of CA diameters according to MSCT and CAG. At the same time, 70-80% of CA segments are suitable to determine the exact degree of stenotic changes [19].

The local myocardial contractility is determined with: echocardiography (ECHOCS), stress-ECHOCS, stress-ECHOCS with tissue Doppler imaging, and the radiopaque or radionuclide ventriculography.

Transient disorders of myocardial functions typical for SMI, are diagnosed with ECHOCS, especially with stress-ECHOCS. Stress-echocardiography not only can detect myocardial ischemia during exercise, but also provides an opportunity to assess the prevalence and severity of the developing disorders of local contractility. The ischemic criteria are considered transient myocardial dyssynergia, as well as the reduced ejection fraction and velocity of circulatory contraction of the myocardium fibers. The advantage of this method of diagnosis of SMI is that it allows not only identifying its presence and determining the localization of ischemic myocardium area, but also assessing the disorders of systolic and diastolic myocardial function, and hemodynamic manifestations of SMI. As the stress tests, the dynamic exercises (treadmill test, stress test), electrical stimulation of the heart, pharmacological tests (dobutamine, dipyridamole, arbutamine, adenosine) were conducted, which provoke ischemia by increasing myocardial oxygen demand or by reducing its delivery to the myocardium. The detected transient myocardial dyssynergia, the reduced ejection fraction and velocity of circulatory contraction of the myocardium fibers indicate its ischemia. A promising trend in the development of stress-ECHCS is an additional application of tissue Doppler imaging, which allows quantitatively assess the results of the test [1- 3, 12].

Radiopaque ventriculography is a radiopaque study of the right or the left ventricle of the heart. Ventriculography provides evaluation of the ventricular contractile function, the configuration of the cavities, identifies the defects of valvular apparatus, aortic and pulmonary arteries, the intraventricular thrombi, the hypertrophic, postinfarction or

ischemic myocardial changes, and heart defects. An important and informative method of SMI diagnosis is a radioisotope ventriculography. By labeling red blood cells (Tc99m), accompanied by ECG-synchronized dynamic scanning and measurement of changes in count rate the blood volume in LV and RV is measured. Analysis of ventricular wall motion, systolic/diastolic function and ejection fraction is used to assess the coronary artery disease and the stratification risk. Signs of myocardial ischemia are: changes in the local motion of the left ventricle wall, decreased ejection fraction, the emergence or expansion of myocardium dyssynergia zones [18,20,21].

Heart imaging with the help of magnetic-resonance imaging (MRI) provides a detailed assessment of structural features of the cardiac and vascular chambers, allows investigating the intracardiac hemodynamics, functional performance of the heart, measuring the velocity of blood flow in large vessels. In most cases, cardiac MRI can serve as a method of a second-line diagnosis upon obscure results of other methods of research (especially ECHOCS). The main advantages of cardiac MRI include: non-invasiveness, lack of radiation exposure, high temporal and spatial resolution, natural contrast created by moving blood, lack of artifacts from adjacent structures, sensitivity to the speed and nature of the blood flow (MR-angiography), the ability to assess morphology function and perfusion in one study, and a significant expansion of the diagnostic capabilities upon using contrast agents. Studying CA during MRI is a difficult task, because they have a small diameter and a complex spatial arrangement, with unstable blood flow; the blood signal in arterial lumen can be merged with a signal from the blood in other blood vessels and cavities, and the position of the arteries varies constantly due to heart rate and its displacement during respiration [22].

**Summary.** According to medical literature, the SMI diagnosis is based on a variety of instrumental methods of research that can objectify the presence of myocardial ischemia. The most commonly used methods are electrocardiographic (ECG at rest and Holter ECG). In case of insufficient data of ECG at rest and Holter ECG, the exercise tests are performed: exercise stress test (EST), treadmill test, TEES.

The assessment of coronary flow reserve, myocardial perfusion can be conducted with the use of coronary angiography (CAG), perfusion tomoscintigraphy (method of single photon emission computed tomography), and electron beam computed tomography.

MSCT-coronary angiography is a noninvasive technique for evaluation of the CA state, which allows identifying their pathological changes. The local myocardial contractility is determined with: echocardiography (ECHOCS), stress-ECHOCS, stress-ECHOCS with tissue Doppler imaging, and the radiopaque or radionuclide ventriculography. A less-used magnetic-resonance imaging (MRI) of the heart provides a detailed assessment of structural features of

the cardiac and vascular chambers, allows investigating the intracardiac hemodynamics, functional performance of the heart, measuring the velocity of blood flow in large vessels. In most cases, cardiac MRI can serve as a method of a second-line diagnosis.

**Conclusion:** Knowing the basic methods of diagnosis allows identifying patients with SMI and starting early treatment, preventing thereby the adverse outcome.

### **Acknowledgements**

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University.

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