COMPLEX RADIATION DIAGNOSTICS OF MYOCARDIAL PERFUSION IN CIVIL AVIATION FLIGHT PERSONNEL WITH THE EXPERIENCE ABOVE 20 YEARS

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INTRODUCTION

Arsenal of radiological methods is the most informative part of all the diagnostic methods of clinical medicine; they allow the *in vivo* study on both the anatomical and functional parameters of various organs and systems. However, each of the methods (R-CT, NMR-tomography, ultrasound and radionuclide methods of research) has its positive and negative aspects and limits of information value.

The latter is especially important for the study on such multi-functional organs and systems, as the heart is. Therefore, a physician has a very important task: to choose clinically appropriate and methodologically most informative method of investigation for a specific clinical purpose and design of the final diagnosis.

In the available literature no data on SPECT-tomography of the myocardium and its combination with other radiation methods in the selected sub-population (contingent) was identified.

TOPICALITY

Within this study, taking into account the specifics of the work (the presence of positive and negative accelerations/overloads, vibrations, noise) we have chosen the method for heart tomography, which allows the closest approach to the pathophysiological mechanisms of myocardial perfusion disorders.

The state of myocardial perfusion in patients without myocardial infarction, but with severe pains of varying degrees of intensity, is a relevant and challenging clinical problem. It is even more complicated because of the numerous ambiguous factors affecting development of the pathological process occurring in flight personnel with experience not less than 20 years.

Among the factors that may affect the state of myocardial perfusion are additional loads to which the aircrew is exposed.

GOAL AND TASKS

Based on the above, the purpose of the present study was to evaluate myocardial perfusion in flight personnel via identifying features of this disorder. To achieve these objectives the following tasks were set forth:

1. Detection of myocardial perfusion disorders,
2. Identification of the site of disorder and the total area of myocardial damage;
3. The response of myocardium to pharmacological tests and to determine the features of changes in response to the stress factor;
4 Identification of general and specific patterns of myocardial perfusion disorders of the left ventricle at rest and under pharmacological stress and their comparative characteristics.
5. Features of violations perfusion in flight personnel.

MATERIAL AND METHODS

The survey involved 16 people (pilots with experience of over 20 years) with no clinical or laboratory signs of myocardial infarction.

Among the causes of visits to a doctor there were: unstable angina, arrhythmias and blood pressure disorders.

Method of research: perfusion scintigraphy with radioactive technetium and MIBI kit (technetril). Investigations were carried out on «SPECT» tomograph («Mediso», Hungary). The tomography step was 5.6°, angle of detector circulation around the heart — from 60° to 240°. The number of frames: 32. The image made 5 mm in all three tomography axes. Investigations were carried out in 2 stages: the first stage was performed an hour after intravenous administration of Tc-MIBI with activity 22–24 mCi, the second stage occurred immediately after the first scan /tomography taking with the intake of 2 pills of nitroglycerin. Final evaluation of the information received was done in the form of a qualitative and quantitative assessment of

myocardial perfusion disorders in all three axes, all the slices based on a «map of the heart» and the total percentage of left ventricular myocardial damage [1, 2, 4].

Then a comparative characterization of tomoscintigrams was conducted before and after the loading test.

In order to optimize the interpretation of tomographic data we selected the following standards: IAEA software package and IAEA recommendations for evaluation of perfusion disorders.

Normal capture was estimated at diffusely uniform redistribution of the indicator from 100% to 70% of the administered activity, slight reduction of blood flow — 70–50%, average — 50–30%, significant — 30–10%, the absence of perfusion — 0–10%.

Another point of reference for assessing the extent of damage in the left ventricular myocardium is the number of damaged segments in a 9-segment model.

Upon the damage of 1–2 segments there was a minor perfusion disorder, at involvement of 3–4 segments — moderate, at more than 5 segments — significant impairment of perfusion.

RESULTS AND DISCUSSION

The following results were obtained:

1. Varying degrees of perfusion disorders were found in all subjects.
2. The most vulnerable areas were localized along the apex-septal and antero-lateral wall of the left ventricle. The largest areas of damage were on the back wall, in the direction from septum o lateral parts. Accordingly, the degree of reduction was 50%, the number of segments made 3–4.
3. The 90% of patients showed signs of concentric left ventricular hypertrophy, 10% — the signs of eccentric hypertrophy; the degree of reduction in the latter reached 70%, the number of segments was 4–5.
4. Upon the comparative evaluation of the two-stage study (rest and stress) mainly the signs of activity redistribution (91%) were identified; signs of latent defects made 57%, signs of steal syndrome — 36%, improvement in overall perfusion was recorded only in two cases improving local zones — in 36–38%. The latter fact (improvement of local zones) is the most important clinical and pathophysiological feature of the possible recovery of myocardial perfusion.

The analysis of tomoscintigraphy results suggests that state of myocardium perfusion in the left ventricle in flight personnel might serve a model of hibernating myocardium described by Rahimtoola S.H. (1980) and Narahara R.A. (1990).

The main issue of this communication was defining areas of reversible ischemia and unviable myocardium areas, whereas disorders of the perfusion, as presented by Narahara RA (1990) can be also identified in the areas of viable but «hibernating» or stunned myocardium.

Perfusion single-photon imaging at rest and myocardial scintigraphy in combination with nitroglycerine test enabled using the quantitative analysis method to specify the zones of increased accumulation of the indicator. Myocardial viability (in different portions of the left ventricle myocardium) was detected almost in one third of patients.

The authors, Rahimtoola S.H. and Narahara R.A. [6, 7], have identified the principal / fundamental point of hibernation essence: «inhibition of myocardial contractile function occurs in parallel» with the ischemia degree. At the same time, reducing inotropic function of hibernating myocardium appears as regulatory defensive reaction in response to an energy deficit in cardiomyocytes. If at worsening of myocardial perfusion the total ejection fraction remains high, it is considered a good prognostic sign and vice versa: if upon the worsened perfusion of myocardium there is a simultaneous decrease of both the total ejection fraction and the local one, then it is a bad predictive sign.

All clinical states that can lead to hibernating myocardium are met in the surveyed contingent due not only professional, but also, and especially, noxious continuing professional factors of work.

From a practical point of view, the presence of hibernating myocardium is a significant predictor of recovery in the impaired perfusion.

CONCLUSION

With a decrease in coronary blood flow to a critical level or at the relative deficiency of myocardial oxygen supply the hypoxia occurs at the level of «respiratory chain». As a consequence of aerobic catabolism termination, the glycogenolysis and anaerobic glycolysis are increased; the volume of energy production is a direct function of myocardial perfusion.

This latter emphasizes the importance to study myocardial perfusion for determination of ischemia degree of the heart muscle.

The effective perfusion helps to restore contractile function of reversibly damaged cardiomyocytes only after normalization of energy production and reduction of the intracellular calcium concentration. Sometimes the recovery of contractile function of the heart after the restoration of coronary blood flow occurs with some delay («stunned myocardium») [3, 8].

In the absence of adequate reoxygenation cardiac ischemic changes of intracellular metabolism lead to

structural and morphological changes in cardiomyocytes until their death with post-infarction scar formation. The consequence of such disorder (damage) is irreversible disturbance of myocardial contractile function [3].

REFERENCES

1. **Kramer A.A.** Radionuclide methods of investigation of the myocardium. Moscow. 1982. 78p. (published in Russian).
2. **Chernov V.I., Salpagarov S.M. et al.** Methodological aspects of using SPECT with Tc-99m- technetril for prognosis of coronary heart disease course. Medical Radiology and Radiation Safety. 2002, №1, p. 39–40 (published in Russian).
3. **Lishmanov Yu.B., Chernov V.I., Babokin V.E. et al.** Scintigraphic, ultrasonic evaluation of myocardial viability of hibernating myocardium upon dopamine / Medical Radiology and Radiation Safety. 2002, №1, p. 46–53 (published in Russian)..
4. **Kuzin A.I., Gabbasova L.A., Vazhenin A.V.** Clinical and radiological analysis of myocardial scintigraphy with Tc-99m - technetril / Vestnik rentgenologii I radiologii (Bulletin of Roentgenology and Radiology). 1999, №1, p. 9–11 (published in Russian).
5. **Narahara R.A., Villanueva-Mayer J., Thompson C.J.**/ American Journal of Cardiology, 1990, 66(20), p.1438–1444.
6. **Rahimtoola S.H.** Importance of diagnosing hibernating myocardium: how and in whom./American Journal of Cardiology, 1997, 30, p.1701–1706.
7. **Rahimtoola S.H.** The hibernating myocardium. American Journal Hearth, 1989, 117, p.211–221.
8. **Makarova E.V., Chernov, V.I. et al.** Radionuclide diagnostics of the metabolic processes of the myocardium in ischemic heart disease / Medical Radiology and Radiation Safety, 2005, №3, -p.53–60.