Научная публикация

HEMORHEOLOGICAL, MICROVASCULAR AND HEMODYNAMIC DISORDERS DURING CORONARY HEART DISEASE

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Coronary artery disease (CAD) is the leading cause of cardiovascular mortality worldwide. Even more, it is projected that CAD mortality rates will double from 1990 to 2020, with approximately 82% of the increase attributable to the developing world [5]. Prevention and targeted control of risk factors for CAD could potentially reduce the impact of CAD in the developing world. Many scientists indicate the significance of the monitoring of hemorheological patterns during various forms of the ischemic heart disease [2,6]. The increased RBC aggregation was observed in the patients in the following order: unstable angina, acute myocardial infarct. The best correlation was observed by integration of large aggregate fraction as a function of shear stress [1]. Furthermore, several studies demonstrated a strong relationship between ischemic vascular disease and worsening in hemorheological parameters mainly in patients affected by ischemic vascular diseases [10]. Some scientists suggested that hemorheological parameters constitute independent risk factors for ischemic cardiovascular events. It has been suggested that the whole blood viscosity, plasma viscosity and erythrocyte aggregation might be influence by the lipids and plasmatic lipoproteins [3]. Our resent studies showed significance of the hemorheological disorders in pathogenesis and development of the coronary heart disease [11].

Aim of the present study was to investigate relationship between hemorheological, microvascular and hemodynamic abnormalities during various forms of the chronic coronary heart disease.

Material and methods. We investigated 64 patients with chronic coronary heart disease – angina, functional classes I - I V, heart failure I-IV (NYHA), and unstable angina. For evaluation of the hemoreological disorders we investigated their most significant symptom, the erythrocyte aggregability, with the "Georgian technique" that provided us with direct and quantitative data [7]. We investigated also the tone of the hands resistance arteries with an original non-invasive technique based on measurement of the flow velocity changes in the radial arteries by using the Doppler technique during standardized postischemic hyperemia [8]. Echocardiographically we studied the standard characteristics of the left ventricular function (systolic and diastolic volume, its mass and ejection fraction). ECG by standard leads and blood pressure was measured in all patients.

Control group was consisted of 20 healthy subjects, 10 men, 10 women with a mean age of 57+2 years. This group had no evidence of a cardiac disease; they were taking no medication at the time of testing, and had a normal resting electrocardiogram.

Results and their discussion. We found that the rheological disorders are manifested in the early stages of the disease before its functional manifestation. The most pronounced hemorheological disorders were in evidence in the patients with unstable angina and heart failure (Fig. 1). There was a positive correlation between erythrocyte aggregability index and the severity of the disease ($P<0,01$). As to the arteriolar resistance index, it was increased only in 45 per cent of all the investigated patients and no significant difference between the patients with the heart failure and without it was found (Fig. 2). There was a negative relationship between erythrocyte aggregability and the ejection fraction of the left ventricle and a positive correlation between erythrocyte aggregability and left ventricle hypertrophy ($p<0,01$). ECG changes were most pronounced in patients with high levels of the erythrocyte aggregation.

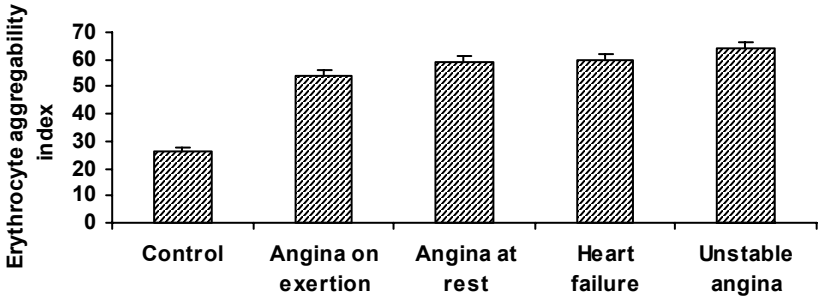

Fig. 1. Erythrocyte aggregability indices in healthy controls and in patients with coronary heart disease

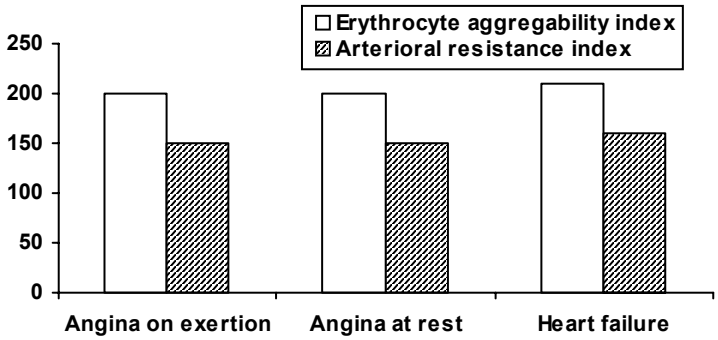

Fig. 2. Relative (per cent) changes of the eythrocyte aggregability and of the arteriolar resistance indices during coronary heart disease.

RBC aggregation is a major determinant of blood viscosity, particularly under the conditions of low shear stress, and therefore it affects blood flow dynamics mainly within the microcirculation, where such conditions prevail [9]. Experimental models and clinical studies demonstrate the potential of RBC aggregation to hinder blood flow through the microcirculation in various diseases [1]. The formation of "sludge" blood under these conditions is assumed to cause tissue hypoxia and acidosis, and to lead to the metabolic disturbances. A pathogenic role for erythrocyte aggregation has been postulated in acute coronary syndromes [2,6]. These studies examined the blood viscosity, not the erythrocyte aggregation, which seems to be most important from our standpoint. Furthermore, we mentioned the importance of the erythrocyte aggregation for the vessels injury. Rheological disorders allow atherogenic particles to be longer exposed to the vascular endothelial and consequently greater interaction between the blood cells themselves and the vessel wall [3]. Our data show that arteriolar resistivity is high enough even in the beginning stages of the coronary heart disease and doesn't change significantly the currency of severity of the disease (Fig. 1). It means that arteriolar walls undergo early changes, before clinical confirmation of the disease is occurred. Simultaneously we observed that erythrocyte aggregability was progressively increased during the severity of the disease (Fig. 2), especially the acute forms (infarction, cardiogenic shock). Interrelationship between the erythrocyte aggregability and arteriolar resistivity is direct in the early stages of the disease, but there is no significant difference between them in patients with and without heart failure. This means that the blood vessels lost there function totally, not only in one region of the coronary supplement. The increased blood viscosity provokes increasing of the peripheral resistance and overloading of the heart muscle with its hypertrophy, which determines high-risk of sudden death. This condition deteriorates the blood circulation in the whole body especially in the regions with more superfine structure of microcirculation (the heart, the brain). These approaches were postulated in the European guidelines on cardiovascular disease prevention, which indicated that the etiology of myocardial infarction, ischemic stroke and peripheral arterial disease is similar and, indeed, recent intervention trials have show that several forms of therapy prevent not only coronary events and revascularizations but also ischemic stroke and peripheral artery disease [4].

We concluded that increased erythrocyte aggregability is a high risk-factor of developing coronary heart disease and sudden death, and therefore they must be monitored and controlled in all risk-groups of this disease.

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SUMMARY

HEMORHEOLOGICAL, MICROVASCULAR AND HEMODYNAMIC DISORDERS DURING CORONARY HEART DISEASE

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Significance of the hemorheological disorders in development of acute vascular syndromes is presently well known, but their role in pathogenesis of chronic coronary heart disease has not been yet sufficiently analyzed. Aim of the present study was the investigation of the relationship between the hemorheological, vascular and hemodynemic factors responsible for development of the coronary heart disease.

We investigated 64 patients with coronary heart disease of the functional classes I-IV with and without the heart failure. For evaluation of the hemorheological disorders we investigated its most significant symptom, the erythrocyte aggregability, with the "Georgian technique" that provided us with direct and quantitative data. We investigated also the tone of the hand's resistance arteries with an original non-invasive technique based on measurement of the flow velocity changes in the patients and in the healthy controls radial arteries by using the Doppler technique during standardized postischemic hyperemia. Echocardiographically we studied the standard characteristics of left ventricular function (systolic and diastolic volume, its mass and ejection fraction). ECG by standard leads and the blood pressure were investigated in all patients.

We found that the rheological disorders are manifested in the early stages of the disease before its functional manifestation. The most pronounced hemorheological disorders were in evidence in the patients with unstable angina and heart failure. As to the arteriolar resistance index, it was increased only in 45 per cent of all the investigated patients and no significant difference between the patients with the heart failure and without it was found. There was a negative relationship between erythrocyte aggregability and the ejection fraction of the left ventricle and the positive correlation between erythrocyte aggregability and left ventricle hypertrophy ($p<0,01$). We concluded that the blood rheological disorders represent themselves a factor that plays a significant role in pathogenesis of the coronary heart disease. They are predictors of the disease and not only risk factors as it is generally believed. Measurement and correction of these disturbances in its early stages have a high clinical significance.

Key words: Erythrocyte aggregability, ischemic heart disease, arteriolar resistance.

РЕЗЮМЕ

ГЕМОРЕОЛОГИЧЕСКИЕ, МИКРОСОСУДИСТЫЕ И ГЕМОДИНАМИЧЕСКИЕ НАРУШЕНИЯ ПРИ КОРОНАРНОЙ БОЛЕЗНИ СЕРДЦА

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Известно, что гемореологические нарушения в развитии острых сосудистых синдромов имеют особое значение, однако их роль в патогенезе хронической ишемической болезни по сей день не изучена. Целью данного исследования явилось определение взаимосвязи между гемореологическими, микрососудистими и гемодинамическими факторами в патогенезе хронической ишемической болезни сердца.

Нами обследованы 64 больных с коронарной болезнью сердца - стенокардия-функциональные классы I-IV с сердечной недостаточностью. Изучена агрегация эритроцитов оригинальным методом, разработанным сотрудниками микроциркуляторного центра Грузии института физиологии им. Бериташвили АН Грузии. Изучался тонус резистивных артерий методом, основанным на принципе Допплера в условиях искусственно вызванной ишемии. Эхокардиографически определяли стандартные показатели левого желудочка. ЭКГ и измерение артериального давления проводили всем больным.

Исследования выявили, что реологические нарушения имеют место на ранних этапах болезни, опережая ее клинические проявления. Самые отчетливые нарушения установлены у больных с нестабильной стенокардией и сердечной недостаточностью. Выявлена положительная корреляция между агрегацией эритроцитов и тяжестью течения болезни. Что касается резистивности артерий, ее индекс у всех обследуемых больных был повышен только на 45%. Статистически значимого различия у больных сердечной недостаточностью и без нее не обнаружено. Положительная коррелятивная связь выявлена между агрегацией эритроцитов и гипертрофией левого желудочка, а отрицательная взаимозависимость - между повышенной агрегацией и фракцией выброса левого желудочка ($p<0,01$). Таким образом, нами установлено, что реологические нарушения являются предикторами ишемической болезни сердца и могут быть использованы в качестве маркеров определения тяжести течения болезни.

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