

Subsection Astrobiology

FEATURES OF VASCULAR ENDOTHELIAL FUNCTIONING IN HEALTHY PERSONS IN DIFFERENT PERIODS OF SOLAR ACTIVITY

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ABSTRACT. Functional properties of vascular endothelium in healthy persons had been studied by probe with induced ischemia depending on a solar activity (SA) period during the 23rd solar cycle. The blood viscosity had been estimated before and after occlusion test. The nascency of angiospasm in a low SA is accompanied by adaptive increase of a blood flow property, and in a high SA this mechanism is been losing. So, in healthy persons the period of SA determines functional properties of vascular endothelium.

Key words: vascular endothelium, solar activity.

It is known that a solar activity (SA), determining by the number of sun spots and measured in Wolf numbers, changes after 11-years cycle. The Earth magnetic field strength caused by solar flares is one of the facts of adaptation failure and acute-on-chronic diseases. Geomagnetic activity causes feebleness of capillary circulation in healthy persons, increasing a blood viscosity (BV) and erythrocytes aggregation (Breus, 2003; Gurfinkel et al., 1995). There is no information in accessible medical literature about functional properties of vascular endothelium in the period of a SA.

The study aimed the research of functional properties of vascular endothelium in healthy persons by probe with induced ischemia depending on a solar activity (SA) period during the 11-years solar cycle.

During the last 23rd solar cycle (September, 1996 – September, 2007) 80 healthy people had been examined: 40 of them – in the period of a high SA, 40 – in the period of a low SA. The groups were matched in age and sex characteristics.

To characterize the SA in the Wolf numbers there had been used the data of the Institute of space exploration of RSA. An average value of the Wolf numbers in the period of a high SA was $112,0 \pm 2,9$, in the period of a low SA - $62,4 \pm 3,9$ ($p < 0,05$).

The functional ability of endothelial vessel wall had been estimated by the occlusion test based on a modeling of a short 3-minute local ischemia, stimulating by the fixing of a sphygmomanometer on a patient's shoulder, and the pressure 10 mm of mercury higher than a systolic

pressure (Baluda V.P. et al., 1992). The substances that decrease the blood clotting and thrombocytes aggregation, influence the blood viscosity and erythrocytes functional properties, are released into the blood flow from a vascular endothelium at the occlusion test. The occlusion test models an angiospasm and let estimate a reserve of vessel wall of the subject at the short ischemia condition.

The BV had been estimated under the three rate-of-shear (200 sec^{-1} , 100 sec^{-1} , 20 sec^{-1}) with the help of the rheometer AKP-2 before and after the occlusion test (OT). There had been also fibrinogen measured (FG), as its increase in a blood plasma causes an increase of a BV.

We had introduced an index "rheological index of a vessel wall" (RIVW, relative unit – r.u.), determining as a relation of "BV after OT" value to "BV before OT" value. The RIVW lets assay the vascular endothelial ability to release substances influencing the BV into blood at the ischemia condition. In releasing the substances, decreasing the BV, RIVW has a value less than 1. In the case of an increase of the BV after OT, RIVW has the value more than 1, which indicates a deterioration of endothelium-dependent regulation of a blood flow property at the angiospasm condition. RIVW, to a certain extent, reflexes the endothelium condition in the vessels of a small, medium and macro diameters, which is clear from the BV analyze under the corresponding rate-of-shear (20 sec^{-1} , 100 sec^{-1} , 200 sec^{-1}).

It had been established that the blood flow property in healthy persons depends on the period of a SA as at rest, as at the angiospasm conditions (modeling by the OT).

In the period of a low SA the BV at rest under all rate-of-shear was lower ($p < 0,05$) then in the period of a high SA (Table 1).

At the same time, in the period of a low SA the BV under all rate-of-shear after OT adaptively decreases ($p < 0,05$) (Table 1), which indicates the release of substances increasing the blood flow properties at the angiospasm condition. This reaction is directed on the prevention of a hypoxia developing in the decreasing of a blood flow through a stenosed vessel. RIVW has a value < 1 .

The given type of a functioning of endothelial vessel wall can be considered as a totally compensated.

In a high solar activity there are no statistically valid changes in the BV 200 sec⁻¹, 100 sec⁻¹, 20 sec⁻¹ at the OT ($p > 0,05$) (Table 1). So, an increase of a SA leads to changes in functional properties of vascular endothelium: after OT there is no compensatory decrease of a BV, it means that there is no releasing of the substances increasing a blood flow property at the angiospasm. The changes in functional properties of vascular endothelium in the period of a high SA can also be connected with a higher ($p < 0,05$) fibrinogen concentration comparing with the period of a low SA (Table 1). In the period of a low SA RIVW has a value ≈ 1 . This type of a functioning of endothelial vessel wall should be considered as a subcompensated, as the absence of an adaptively improvement of a blood flow property at the angiospasm condition pre-determines hypoxic changes in organs at strain.

Table 1: Dynamic of a blood viscosity and fibrinogen concentration at the induced ischemia in healthy persons in different periods of solar activity ($M \pm m$)

Indices	Period of a solar activity	
	High solar activity (n=40)	Low solar activity (n=40)
BV 200 c ⁻¹ , mPa·sec before OT	6,47±0,33 **	4,49±0,22
after OT	6,56±0,52	3,81±0,15 *
BV 100 c ⁻¹ , mPa·sec before OT	7,06±0,40 **	4,54±0,21
after OT	7,12±0,64	3,89±0,21 *
BV 20 c ⁻¹ , mPa·sec before OT	9,62±0,46 **	5,29±0,33
after OT	9,69±1,00	3,98±0,24 *
FG, g/l	3,59±0,20 **	3,09±0,17

Note: OT – occlusive test;

* - the difference between index values before and after OT is statistically valid ($p < 0,05$);

** - the difference between indices of a high and a low SA is statistically valid, $p < 0,05$.

It should be noted that in the period of a low, as well as in the period of a high SA, the endothelium reaction on the OT was unidirectional in the vessels of different diameters. In the period of a low SA compensated type of endothelium functioning had been revealed in the vessels of small, medium and macro diameters under the rate-of-shear (20 sec⁻¹, 100 sec⁻¹, 200 sec⁻¹) correspondingly. In the period of a high SA subcompensated type of endothelium functioning had been revealed also in the vessels of all studied sizes (small, medium and macro diameters under the rate-of-shear 20 sec⁻¹, 100 sec⁻¹, 200 sec⁻¹ correspondingly).

A unidirectionality of endothelium reactions in the vessels of different diameters indicates the retention of basic mechanisms of regulation in healthy people independent from the period of a SA. So, compensatory-adaptive mechanisms of functional properties of vascular endothelium at a SA change, change first in the local level (vascular system) keeping more complicated central adaptive processes unchanged. This, probably, explains normal functioning of a healthy organism in the period of a low and high SA.

The results of the study show that change in a SA causes blood rheological properties and compensatory-adaptive mechanisms of functional properties of an endothelial vessel wall in healthy people on retention of central regulating mechanisms. At the same time a period of a SA determines features of functional properties of vascular endothelium at the angiospasm condition: an angiospasm at a low SA is accompanied by an adaptive increase of a blood flow property ($RIVW < 1$, compensated type of endothelium functioning), at a high SA this mechanism is lost ($RIVW \approx 1$, subcompensated type of endothelium functioning).

The given results let us erect a proposition of a main role of a vascular endothelium as a primary aim for effects in a healthy organism at a changed solar activity.

References

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