Saratov State Medical University named after V.I. Razumovsky

Light effect on the microvasculature of the skin according to the data of laser Doppler flowmetry in the experiment

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Relevance

Biological rhythms determine the cyclicity of various processes that ensure the vital activity of the organism. The consistency of circadian rhythms with an external pacemaker contributes to the maintenance of homeostasis and adaptation of the body to changing environmental conditions. Pathological mismatch of biorhythms as a result of a violation of the natural photoperiod is called jet lag.

Today, the risk of jet lag is increasing as a result of increased levels of light pollution.

Pathologies of the cardiovascular system are the leading causes of death and disability in the world. The key moment in the development of the pathology of the cardiovascular system is impaired blood circulation at the level of the microvasculature, which ensures the trophism of all tissues and organs. Progressive structural damage to endothelial cells, leading to endothelial dysfunction, acts as the earliest stage in the development of nosological forms of cardiovascular diseases

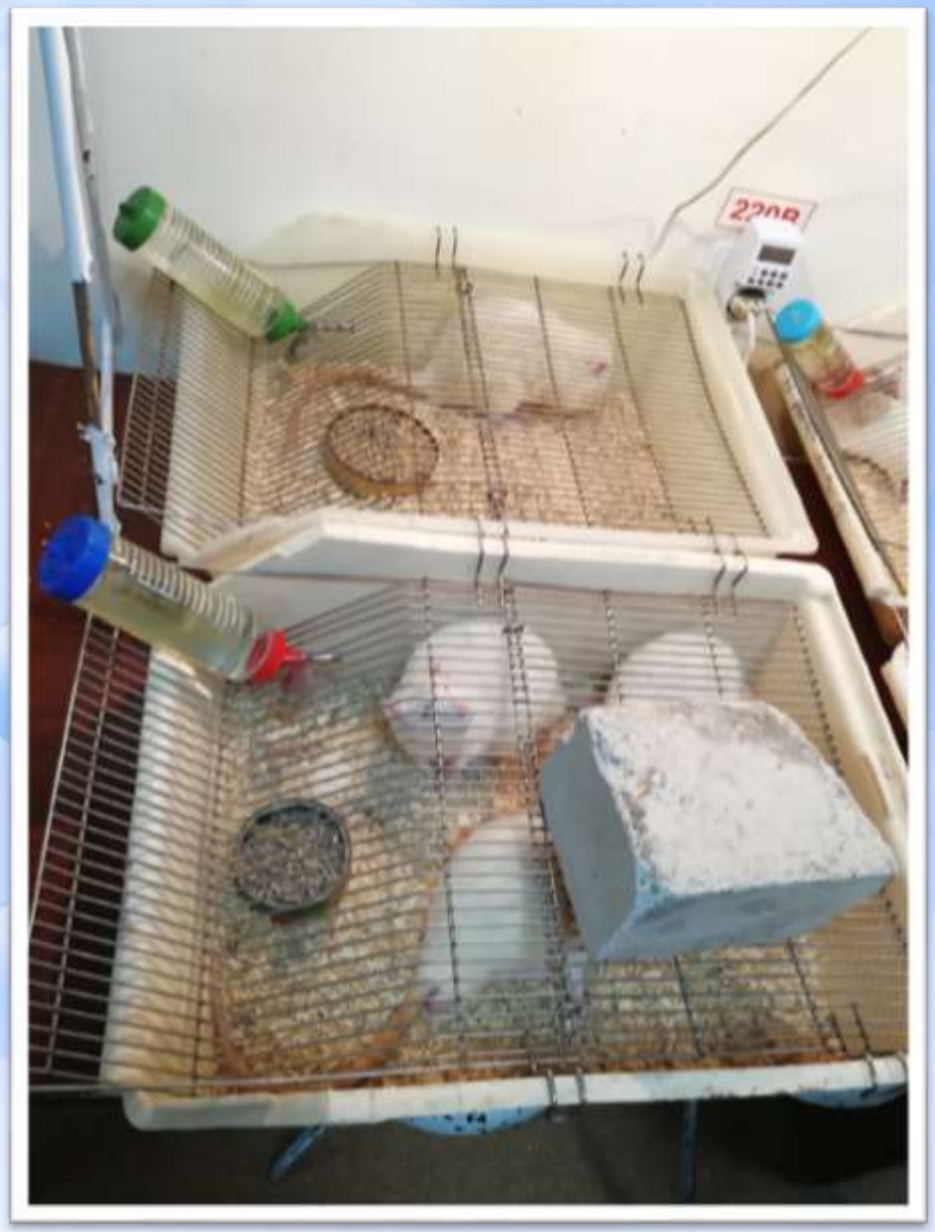
Purpose

To study the effect of jet lag (models 18: 6) on the functioning of the regulatory mechanisms of the microcirculature in the experiment.

Materials and methods

All experiments were carried out on the basis of the scientific laboratory of the departments of histology and physiology of the Saratov State Medical University named after V.I. Razumovsky in accordance with the Declaration of Helsinki on the humane treatment of animals. Light desynchronosis was formed using the LD 18: 6 model (the duration of the light part of the day was 18 hours, the dark part - 6).

The study was carried out on 20 white outbred male rats weighing 200–250 g, which were randomly divided into two groups - experimental and control. The rats of the experimental group experienced the influence of the light model LD 18: 6 for 21 days. Animals of the control group were kept in natural light conditions throughout the experiment.



Materials and methods

For studing microcirculation by laser Doppler flowmetry (LDF), we used a LAKK-OP analyzer (manufactured by NPP Lazma, Russia). Registration of LDF-grams in the experimental group was carried out on the 10^{th} and 21^{st} day of the experiment. Control LDF-grams were obtained from intact animals of the control group.

5 minutes before the recording LDF-grams for anestesia the rats were injected intramuscularly with a combination of Telazol (Zoetis Inc, USA) at a dose of 0.1 ml / kg and Xylanit (NitaFarm, Russia) at a dose of 0.1 mg / kg.

the LDF method is highly sensitive to changes in the microhemodynamic situation in the vascular bed, therefore, it has an indisputable advantage over other methods for studying microcirculation, since it allows one to assess the state of functioning of blood flow control mechanisms.

Materials and methods

The light guide probe was fixed on the skin of the distal hind limb of the animal. The length of the recording was 8 minutes. Perfusion index (M) was determined in perfusion units (pf.units) and absolute amplitudes of endothelial (0.01-0.076 Hz), neurogenic (0.076-0.2 Hz), myogenic (0.2-0.74 Hz) , pulse (0.8–1.6 Hz), respiratory (0.15–0.4 Hz) oscillations of microcirculation using spectral wavelet analysis.

The normalized vibration amplitudes in each of the ranges were calculated according to the generally accepted formula: (A / 3·SKO) 100, where δ is the root-mean-square deviation of blood flow fluctuations.

The results were processed using the Statistica 10 software (StatSoft, USA). Since the data obtained for the most part did not correspond to the law of normal distribution, the nonparametric Mann-Whitney U-test was used to compare the indicators. The changes were considered significant at $p < 0.05$.

Results

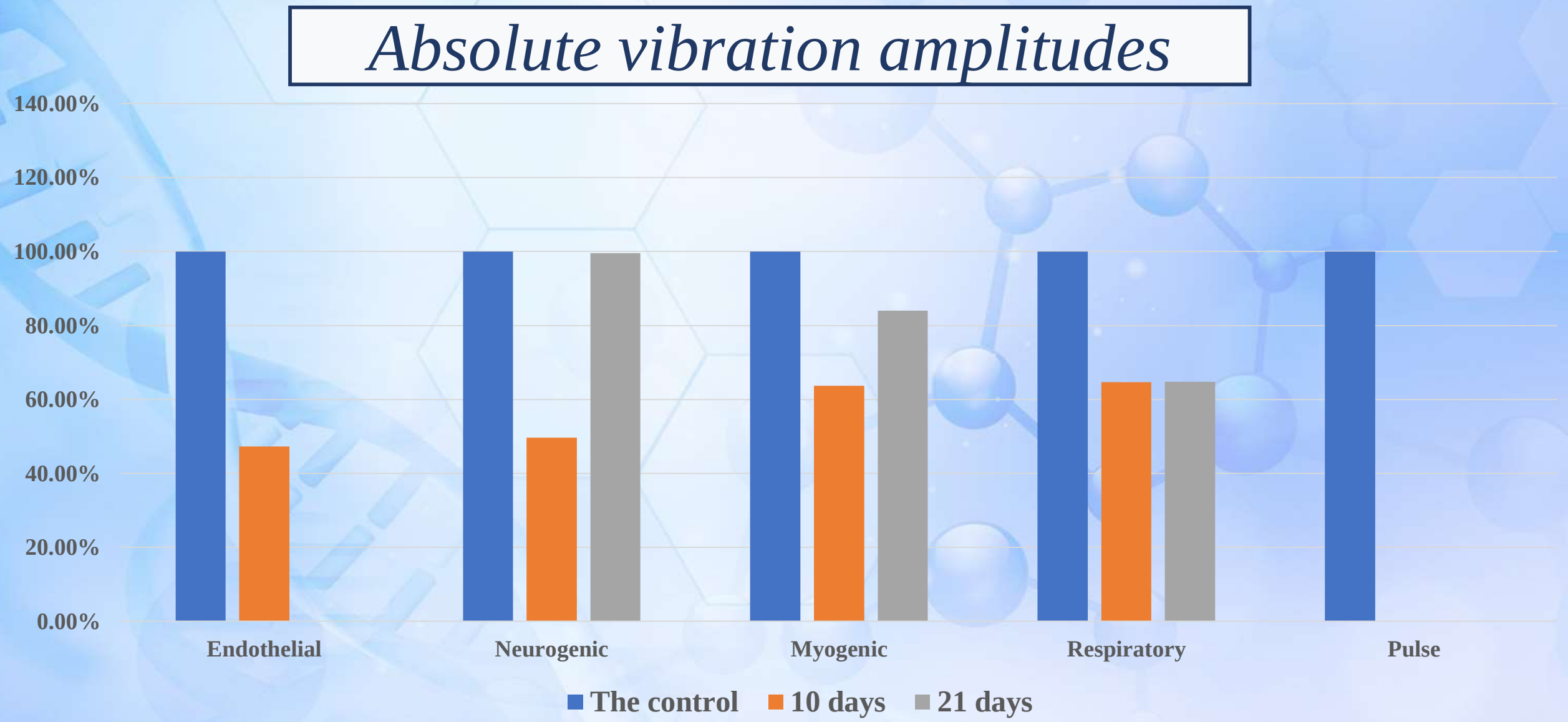
As a result of this study, it was revealed that lighting according to the 18:6 model lasting 10 and 21 days, respectively, led to changes in microhemodynamics, characterized by a decrease in the perfusion index. However, if on the 10th day of the experiment the disturbances in the microvasculature had more transient character than on the 21st day. Because there was a persistent decrease in perfusion on the 21st day.

On the 10th day, at the stage of regulatory changes, perfusion indices significantly decreased due to active factors (endothelial, neurogenic and myogenic), while a decrease in the amplitudes of neurogenic oscillations is an indicator of an increase in arteriole resistance, a decrease in endothelial amplitudes indicates developed endothelial dysfunction, a decrease in the myogenic factor is also indicates increased resistance to muscle tone of the precapillaries. There is also a significant decrease in the respiratory absolute amplitudes of oscillations (passive factor), which indicates an increase in microcirculatory pressure. Thus, we can assume that perfusion in the microvasculature decreased due to increased vascular resistance and a corresponding increase in pressure at the precapillary level.

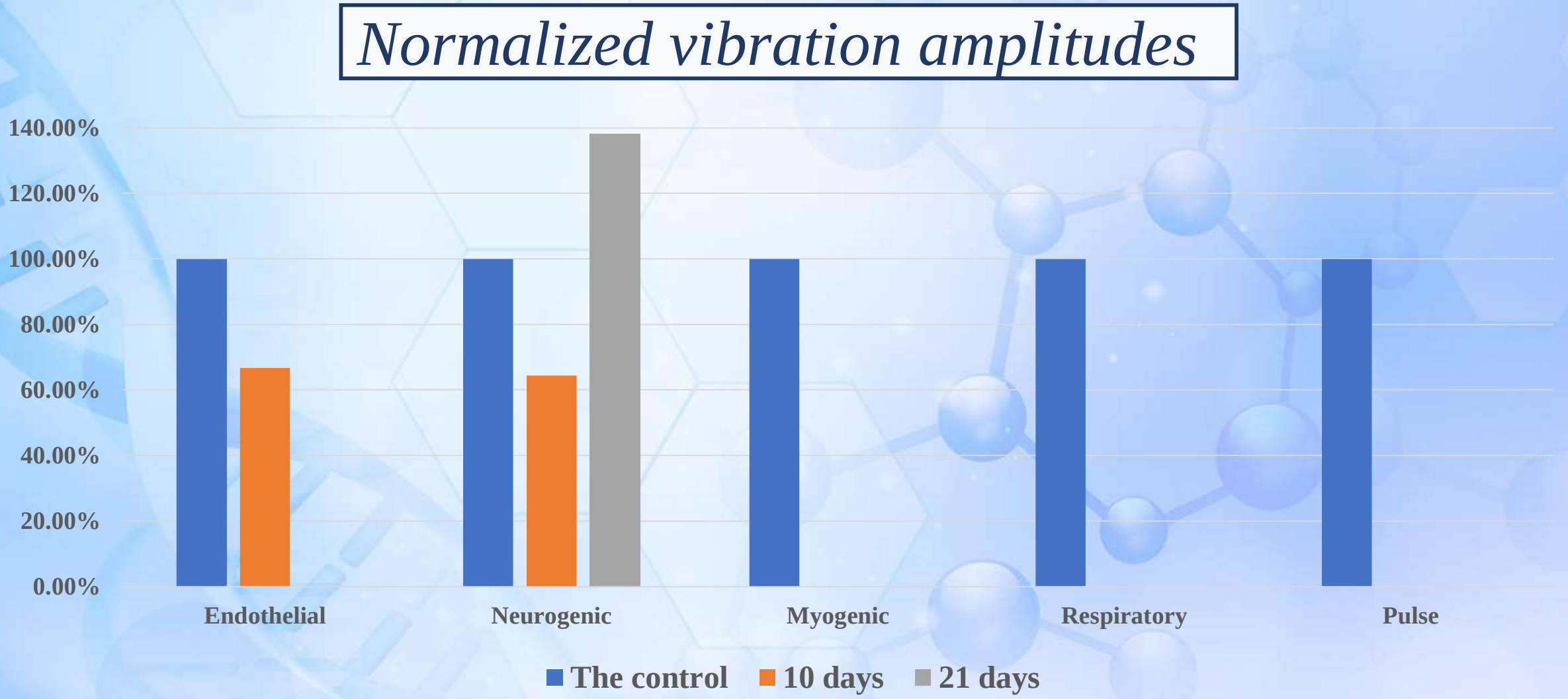
Results

On the 21st day, the trend that began on the 10^{th} day persisted, the indicators of the absolute amplitudes of fluctuations were also reduced in comparison with the control group. The respiratory factor on the 21^{st} day was significantly reduced compared to the 10^{th} day, which allows us to assume its main role in the decrease in perfusion. The amplitude of neurogenic and myogenic fluctuations is still significantly reduced compared to the control, but already higher than by the 10^{th} day and the endothelial fluctuations are already higher than in the control group, which may indicate the beginning of the work of compensatory mechanisms at the level of microcirculation.

Results


Absolute vibration amplitudes
140.00%
120.00%
100.00%
80.00%
60.00%
40.00%
20.00%
0.00%
Endothelial
Neurogenic
Myogenic
Respiratory
Pulse
The control
10 days
21 days

Results


Normalized vibration amplitudes
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60.00%
40.00%
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Endothelial
Neurogenic
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Conclusions

1. This model of jet lag leads to dysregulation of microcirculation and a corresponding decrease of perfusion.

2. Disorders develop gradually, at the initial stage the main role in the perfusion decrease is played by myogenic and neurogenic tone, then endothelial dysfunction and at the final stage the respiratory factor becomes the main factor.

3. Decreased perfusion and progression of disturbances in active and passive factors that regulate microcirculation processes indicate the negative effect of jet lag of this model on tissue perfusion and it becomes a risk factor for cardiovascular pathology.

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Thank you for attention!!!