ABSTRACT

The diabetic foot syndrome is one of the most serious complications of diabetes mellitus (DM), which reduces the quality of life and even leads to amputation at later stages. The study of the blood microcirculatory system functional state in the lower limbs of patients allows one to detect microvasculature functional abnormalities in the earlier stages. The skin blood flow can be assessed using various optical non-invasive technologies. The laser Doppler flowmetry (LDF) method is one of the widely used. The microvascular function is often investigated by analyzing the dynamic variations in the cutaneous blood flow under the influence of stress tests. The local heating is the most widely used test for assessing microvascular disorders in diabetes. The aim of this work was to analyze variations in the microhaemodynamic parameters in patients with DM and healthy volunteers provoked by the local heating test. Experimental studies were carried out by means of the Doppler channel, which is built by using single mode laser module with a wavelength of 1064 nm. A fiber optical probe was used to deliver laser light and register the reflected, shifted in frequency, radiation from the tissue. The optical probe was installed into the hole of the Peltier element, intended for temperature test. Optical probe together with Peltier element was mounted on the dorsal surface of the foot in point located on a plateau between the 1st and 2nd metatarsals. A total of 40 patients with DM (43±10 years old) and 40 healthy volunteers (39±9 years old) took part in this study. Patients were divided into two groups according to the type of diabetes: DM1 (17 patients, 35±9 years old) and DM2 (23 patients 50±6 years old). The study involved 4 stages: registration of LDF-record in the basal conditions for 4 min, local cooling (t = 25 ºC) and a local heating test (t = 35 ºC) for 4 min each, local heating test (t = 42 ºC) for 10 min. The LDF-records were subjected to wavelet analysis using the original algorithm based on the Morlet wavelet. The data obtained showed that local heating tests cause vasodilation in all three groups. Perfusion under heating to 35 and 42 ºC was statistically smaller for patients in comparison to
control group. At the same time, under basal conditions, the blood flow in patients was slightly higher than in volunteers, which indicate a low reserve of the microcirculatory bed. A smaller increase in the oscillations under heating to 35 °C in the frequency range 0.05-0.45 Hz in the patient compared with the control group indicates a lack of nociceptive receptors functioning. A reduced energy of 1 Hz oscillations was also detected in patients with diabetes, which may indicate an increase in the arterial wall stiffness in patients. Interestingly, that the differences noted above were more pronounced in patients with DM1.

Thus, the proposed approach allows one to establish a difference of microhaemodynamic parameters of healthy people and patients with DM, as well as in groups of patients with DM1 and DM2.

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