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Estimation of dielectric parameters of red blood cell membranes by microwave dielectrometry: early diagnostics and treatment control for ischemic stroke patients

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Stroke is one of the leading causes of morbidity and mortality in the world [1]. In vitro measurement of the dielectric parameters of blood and their dynamical changes makes it possible to evaluate the severity of the stroke ischemia and success of the prescribed therapy, as well as identify patients with a probable unfavourable prognosis. In this study the dielectric parameters of suspensions of the red blood cells (RBC) and their ghosts taken from the blood samples of the patients with ischemic stroke have been determined in vitro by the ultra high frequency (UHF) dielectrometry [2] at the operating frequency $f = 9.2$ GHz. Blood samples of fifteen donors and twenty patients with acute ischemic stroke have been collected and incubated with heparin. RBC have been washed out with saline in the centrifuge at $\omega = 3500 \text{ min}^{-1}$ and the RBC suspensions have been used for measurements of the real ϵ' and imaginary ϵ'' parts of the complex dielectric permittivity $\epsilon = \epsilon' + i\epsilon''$ in the UHF dielectrometer. The suspensions of RBC ghosts have been prepared by chemical haemolysis. The preliminary diagnosis for each patient was formulated on the basis of the generally accepted European recommendations for the prevention and treatment of ischemic stroke [3, 4].

Detailed statistical analysis of the measurement data revealed that ϵ' of both RBC suspensions and RBC membranes in patients with ischemic stroke tended to increase after the treatment in comparison with the corresponding indicators of both suspensions and membranes before the treatment. It was also found that the average values of the static dielectric constant (ϵ_s) of the RBC membranes of the patients with ischemic stroke decreased after the treatment, as well as the average values of frequency dielectric relaxation of water molecules (f_D) of RBC suspensions and RBC membranes.

Therefore, a decrease in the real part of the erythrocyte suspensions and membranes and an increase in ϵ_s and f_D may be used as early and reliable indexes of the acute ischemic state. After the treatment all the parameters normalized; therefore, the proposed method can be used for control over the treatment and prognosis of its success. The method is simple and universal; it needs a small amount of the venous blood and standard laboratory preparation of the probe for the UHF dielectrometry study.

Keywords: microwave dielectrometry; dielectric permittivity; red blood cells; acute ischemic disorders

References

- [1] A.D. Lopez, C.D. Mathers, M. Ezzati, D.T. Jamison, C.J. Murray, *Lancet* 367 (2006) 1747.
- [2] S.V. Gatash, *Radiophysics and Electronics* 4(1) (1999) 129.
- [3] Recommendations for Stroke Management: Update 2003. European Stroke Initiative (EUSI): Cerebrovascular Diseases, 2004: 17 (suppl 2), pp. 1.
- [4] T. Kjellstrom, B. Norrving, A. Shatchkute, *Cerebrovasc. Dis.* 23 (2007) 231.