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that the resolution between neighboring brain regions may change according to brain functional activity. is conclusion is illustrated by data of cross-correlation analysis of pO2 uctuations taken from electrodes in associated areas of the brain cortex with distances of 2-3 mm between them, during a 2 minute mental functional test (Raven matrix). Before test the coe cient of cross-correlation between slow pO2 uctuations is about 0.5– 0.7; during test a er 1 min it increases up to 0.7–0.9; a er 2 min, at the end of test, is between 0.7–0.8 , and 2 min a er nishing of the test this coe cient decreases back to the original test value. Reaction to this test taken from surface (cortex) and deep (white matter) electrodes are di erent [17].

C

Collected data and their analysis shows that slow uctuations should be divided into three categories from the point of view of initiation:

1) e most global slow wave activity inside the crania – spinal cavity is initiated by changes of indices in the central hemodynamics: systemic arterial and venous pressure, which have periodic components connected with control processes of the blood circulatory system. Some modulations of volume/pressure relations inside crania - spinal cavities may cause periodical global CSF articulatory movements of the skull bones and as a result, changes in the skull dynamics and its internal volume [41].

2) Changes of blood volume internally were evoked by vascular volume changes initiated by periodical processes of the heart and respiratory activities. ey basically have regional peculiarities, determined by pressure/ ow indices, which are di erent in magisterial arteries and veins, supplying and removing blood from di erent regions in cranial and spinal cavities.

3) Vascular and CSF volume changes, which are connecting with the functional activity of the brain and the activity of its di erent functional structures are based on changes in numerous metabolic processes and, as nal result, changes in local brain blood volume and CSF replacements. ey represent most perfectly the true conditions of brain function and, therefore, are signi cant to accurately monitor brain function under di erent and extreme situations, including measurement of physiological loads during diving and swimming training as well as a number of pathological conditions.

e one and two models have now been investigated many times, as has the analysis of REG pulsations used in practice, but the third model is still unclear. is modeling was of interest to our investigators, mainly due to the absence of knowledge until recent times

A

Aim of this paper focuses on the study of slow uctuations connected brain functioning, which re ects the uctuations of brain blood volume and CSF and consequently CSF circulation. Recently, REG methodology was applied to healthy persons at rest conditions, during di erent physiological functional tests and in some cases of pathology. Experiments with awake rabbits have also been conducted. For quantitative analysis of intracranial slow volume uctuations computerized analysis of spectral analysis of fragments of REG continuous recordings were used to evaluate their spectrum characteristics in ranges of 0 – 0.4 Hz (5–15 cycles per minute), provided under di erent conditions. For further evaluation of the data received, Transcrsnial Dopplerography (TCD), and respiratory chest movements (Resp.) were also simultaneously recorded.

ere have not been to date direct methods to quantitatively record periodical changes in uctuations of the liquid media inside closed crania-spinal cavities. In principle, it may be acceptable for these purposes to use MRI methodology. However, the application of MRI is accompanied by some problems (technical analysis subjectivity, absolute subject/patient immobilization, the high price of equipment, di culties with receiving an accurate data signal for analyze by spectral methods). erefore for the purpose of this present study it was necessary to select a methodology, which was direct and could provide comparative data dynamically, and also be applied multiple times safely to the same patient. Additionally, it should be relatively easy to use for complex investigations. Rheoencephalography - REG method, in its most modern version was chosen as the most acceptable. REG methodology provides comparatively quantitative spectrum analysis, due to its calibration capabilities, using as a standard unit value of amplitude the pulse spectral line

e REG method is characterized by a number of important and useful properties. As has been shown by special investigations [14,42], the REG method allows the monitoring of changes in blood and CSF volumes in the brain, where distribution of an electrical eld is initiated by electrodes placed on the skin surface of the head.. By varying the electrode placement measurement con guration of the head could be changed. erefore, REG allows the investigation of di erent regions of the cranial cavity. REG does not create any biological in uence by the electrical current applied and therefore it is possible to provide multiple observations of the same subject.

In this study we have used a new REG modi cation – Multifrequency (MultiREG), which permits simultaneously recording on three frequencies: 16, 100 and 200 kHz - manufactured by “MISTAR” (Russian Federation). is unit provides information concerning the water content of brain tissue and additional information re ecting intracranial water volume changes. In this study the MultiREG goal was to nd the optimal conditions to receive valid spectral diagrams and to establish any factors which could be involved in changing its pattern. All investigations were conducted with fronto-mastoid electrode position for both hemispheres to evaluate spectrum hemispheric asymmetry.

CD

For purpose of evaluation of CSF mobility, a fragment of recording was selected for spectrum analysis, using the MultiREG, TCD in basement of MCA by “MultiDop” (DWL, Germany) and chest respiratory movements by a specially constructed chest band. By such selection of MultiREG electrodes and TCD probe positions the current distribution inside the cranium includes the entire brain region and separately each hemisphere, which is supplied by blood through the MCA. is allows us to receive comparable data for di erent subjects and di erent physiological conditions and to compare the MFREG uctuations with linear blood velocity in the basement of the MCA.

A

Animal experiments were deemed necessary for receiving additional data at two directions to investigate how common results of spectral humans and animals are. Results of such investigations are opening the possibilities to study with animal such particular conditions, which is may be unacceptably 05 trving additional mechanisms of some drugs. For investigations healthy animal – rabbits

at 100 and 200 kHz. is indicates that some redistribution between blood ow control inside and outside of skull has taken place.

C **CD**

e changes of TCD spectral diagrams on Figure 7 also change the functional circulatory systems and in the relationships between them. e phenomenon of slow uctuations has been known for more than a century. Until the present time, studies of slow uctuations were us, spectrum analysis opens the way for a new noninvasive methodology for investigating the complicated physiological processes; responsible for the brain functioning and the mechanisms that control brain metabolic supply. is could clarify treatments aimed towards healing brain dysfunction with the possibility that the spectrum approach used in this study of low frequency intracranial uctuations. It looks real, that these changes may provide de nitive results, indicate initial functional changes of serious pathology. Described above spectrums of slow uctuations are similar to that of the applications of light spectroscopy to chemistry and physics. So, that is one of directions of wide spectral methodology, already used at the some branches of natural sciences. is technology may also demonstrate new perspectives for application to modern biophysical questions, based on the discovery of presently unknown control systems not only inside cranium, but in other areas of the body.

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References

1.

Yu (2013) Fundamental basis, informational meaning and data analysis of multifrequency reoencephalography. Advances in Bioscience and Bioengineering 1: 8-21.

44. Moskalenko IuE, VaÄ¬nshteÄ¬n GB, Riabchikova NA, Halvorson P, Fielding A, et al. (2010) [Interhemisphere asymmetry of the CSF dynamics and biomechanical properties of the skull]. Ross Fiziol Zh Im I M Sechenova 96: 1005-1013.

45. Moskalenko YE, Ryabchikova NA, Weinstein GB, Halvorson P, Vardy TC (2011) Changes of circulatory-metabolic indices and skull biomechanics with brain activity during aging. J Integr Neurosci 10: 131-160.

46. Ryabchikova NA (2006) The probability prognosis neurophysiological is a factor cognition human activity. Neuroscience for medicine and psychology. Proc. of the 2nd Internat. Interdisciplinary Congress: 155-157, Sudak, Crimea, Ukraine.