FEATURES of BRAIN HEMODYNAMICS RESEARCH at the MULTICHANNEL RHEOENCEPHALOGRAPHY and ELECTROENCEPHALOGRAPHY

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Various diagnostic methods are used for the analysis of brain structures. It is important to note an electroencephalography, a rheoencephalography and infrared spectrometry among them. The rheoencephalography (REG) is a non-invasive method which can repeatedly be used for long registration of general and regional brain hemodynamics in rest and at various functional and pharmacological tests.

The rheography technique is based on tissues impedance registration when the high-frequency current is injected through them. Electric resistance of human body parts depends on volume blood changes in them. It underlies rheograms registration. The rheogram is a graphical registration of tissues electric resistance changes when weak high-frequency current is injected through them. The changes of tissues impedance is caused by pulse increase of an investigated part of a body or an organ volume.

There are bipolar and tetrapolar techniques of rheogram registration. The tetrapolar techniques are used during our investigations. There is an opportunity to put electrodes for the transversal and the longitudinal REG-registration. The longitudinal rheoencephalography from symmetric areas of various head regions is more perspective and valuable as it gives representation about hemodynamics in symmetric brain areas.

To determine blood circulation parameters of brain H. H. Yarullin used the following electrodes positions: frontally-mastoidal (F–M) used for cerebral hemispheres blood circulation registration; frontal (F–F1), frontally-central (F–C) and frontotemporal (F-T) determine blood circulation in anterior cerebral artery; parietotemporal (P–T), roland-temporal (R–T), parietocentral (P–C) and temporotemporal (T1–T2) show blood circulation in medial cerebral artery; occipitomastoidal (O–M) and occipitoparietal (O–P) show hemodynamics parameters of vertebral artery (fig. 1). H. H. Yarullin has suggested the system of leads most full describing brain blood circulation. The disadvantage of this system is the fact of presence a quantity of electrodes that leads to essential inconvenience at tetrapolar REG-signal registration. To determine optimum electrodes quantity we shall visualize anatomic brain structure. If we visualize the main brain arteries and their branches, it is possible to choose common carotid, internal and external carotids, vertebral artery and their branches. The purpose of our experiments was data acquisition about cerebral blood flow in various brain areas. To determine blood circulation parameters in each of areas electrodes were put on large arteries of brain. In our
work three main methods of electrodes fixation have been observed: on the basis of elastic belts, a rigid design and rubber belts helmet.

If there is no asymmetry in blood circulation of brain, the right and left carotid arteries should bring in the equal contribution to brain blood supply. It is obtained that the contribution of both carotid arteries to brain blood supply makes about 80% during experiment. And therefore the remained 20% of blood come in from vertebral artery.

Now we are starting investigation of joint registration of electroencephalographic (EEG) and REG-signals. The joint registration of EEG- and REG-signals supplementing each other can promote not only deep studying of some theoretical questions but also functionalities of diagnostics of vascular and other brain diseases.

The EEG- and REG-signals joint registration assumes use of large number of electrodes. And therefore it is necessary to restrict their quantity so that to save an appreciable part of information that they have. In this case we shall be guided by the anatomic brain structure, namely a brain hemodynamics and its division into 4 lobes. According to EEG-standards, the used electrodes schemes of EEG-leads should correspond to some basic requirements. First, all basic parts should be presented in the scheme, i.e. frontal, central, parietal, occipital and front and back temporal. Secondary, electrodes should put symmetrically concerning a median sagittal line of a head because of essential symmetric of normal EEG.

Observing the projection of the electrodes locations scheme onto brain anatomic structure we have assumed that it is convenient to use 16 monopolar leads at electroencephalography and 10 ones at rheoencephalography (fig. 2). Such electrodes location will provide registration of both signals in each of 4 brain lobes that enables to characterize them separately.
The rubber belts helmet has been developed for joint registration of EEG- and REG-signals. It took place because of joint usage inconvenience of the rigid design for REG-electrodes fixation and electroencephalographic helmet. Therefore we have modernized the helmet for EEG-researches to create the helmet for these both methods.

We have carried out the experiment and recorded signals in 16 EEG-leads and 2 REG-leads (F-M in left and right hemispheres). The developed helmet for joint registration EEG- and REG-signals has appeared convenient during experiment. We have analyzed the results of this experiment and found out correlation of amplitude asymmetry of EEG- and REG-signals in the following leads F3A1, F4A2 and Fs-Ms, Fd-Md accordingly. Thus, it is possible to conclude that the blood circulation changes in internal carotids can lead to changes of electric activity first of all in F3A1 and F4A2 leads.

At joint registration of EEG- and REG-signals we offer to apply 16 monopolar EEG-leads and 10 REG-leads. Further we plan to determine correlation between described above 10 REG- and 16 EEG-leads, research changes electric activity of brain depending on breath phases.

The simultaneously registration of REG and EEG signals allows us to estimate correlation between destruction of electrical activity and blood circulation of brain. First of all it is very important for treating obliterating diseases of vessels and acute stroke. It is known destruction blood circulation preceded of stroke is not momentary process. The problem of cerebral circulation functioning accumulates from little failures to haemorrhage. We can diagnose any variation of cerebral blood circulation in the beginning of stroke treatment but changes in electrical activity of brain are not determined on this period. The second we can
determine changes during the therapeutic session, for example the session of bioadequate electromagnetic stimulation (BEMS) with active diagnostic.

Diagnostic efficiency therapy is proved by blood flow changing in the part of a body under consideration. One of the most appropriate techniques to define blood filling parameters using therapy is the analysis of a rheographic signal. It also enables us to implement synchronized stimulation, which is carried out by rheographic (or pulse wave) signal or by a breathing signal.

Active diagnostics allows a doctor to react immediately to any change in a patient’s condition and to carry out individual selection of therapeutic parameters for each patient. For example form and time parameters of stimulation. At present the most urgent question is the estimation of therapeutic efficiency so that the doctor could choose the most appropriate parameters and the duration of exposure. We suggest using the number of vessel tone changes per unit time as such a parameter.

It is known that the pulse wave signal has several typical forms. They can be classified into hypertonic, normotonic, hypotonic and distonic. These types are determined by using factors DCI and DSI. These factors are amplitudes ratio of the first pulse wave (systolic wave), insicere and the second pulse wave (diastolic wave).

Normally only one type of a vessel tone prevails in a human being. If there is pathology, the vessels tone constantly varies. We have proved that therapeutic stabilises a vessels tone. For example this figure (fig.3) shows the vessels tone indicated by numbers 1(hypotonic), 2(normotonic) and 3(hypertonic) before electromagnetic exposure, during the session and after the exposure. It can be seen that before the session of electromagnetic exposure the vessels tone changes chaotically but after the session it is normalized and tends to one normotonic value.

Thus, the number of changes in the vessels tone per unit time allows us to estimate the patient’s condition objectively and to choose individually optimized parameters of stimulation.

After the number of changes decreases below a certain threshold value, it is necessary to stop a therapeutic session since a refractory period comes (that is tissues become unsusceptible to external stimulation).

The number of sessions composing one BEMS course is chosen in the same way. To implement the methods suggested we have developed special software.
Method and principals suggested in this article allows us to investigate of simultaneously registered signals of electric activity of brain and cerebral blood circulation.

REFERENCES
