RHEOENCEPHALOGRAPHIC STUDY OF THE CEREBRAL HEMODYNAMICS DURING MENTAL WORK

I. P. Markhasina

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Rheoencephalographic investigation of healthy persons engaged in mental work revealed an increase in the volume blood flow through the left hemisphere on account of an increase in the period of filling of the vessels; the incoming blood volume was increased in the temporal region. By the end of the working day these changes were replaced by a disturbance of regulation of the volume blood flow in the temporal regions.

The quantitative study of the cerebral hemodynamics began in the 1950's, when investigations showed that during mental activity no changes take place in the rate of oxygen consumption by the brain tissues, the indices of cerebral perfusion, or the vascular resistance [3, 4]. On the other hand, Ingvar and Risberg [1], who studied the effect of mnestic tests on the cerebral circulation, discovered an increase in the blood flow in the central part of the brain and maintenance of its initial level in the temporal regions. Mamo et al. [2] discovered an increase in the blood flow during the search for a solution in the posterior frontal region, and a wide variety of responses in the temporal regions, ranging from indifference to changes in the blood flow opposite to those in the frontal regions. These contradictory data were the result of the use of different methods, which evidently were not always comparable (Kety's method, isotope and thermistor methods), their use on subjects with diseases of the nervous system, nonobservance of the condition of normality for the subject and the failure to repeat the experiments an adequate number of times.

In the present investigation, the effect of mental work on the state of pulse filling of the blood vessels in the anterior regions of the brain (temporal and frontal) was studied rheoencephalographically.

EXPERIMENTAL METHOD

Tests were carried out on 70 clinically healthy men and women aged 25-55 years. They were engineers by occupation, and on the day of the test they were carrying out their normal work of planning. Rheoencephalograms (REGs) were recorded with the RG-1-01 rheographic apparatus (Biofizpribor), working on an ac frequency of 30 kHz, connected to a two-channel ink-writing electrocardiograph (model 047) for synchronous recording of the ECG. All recordings were made with the subject in a resting state before starting work (at 9 A.M.), and three times during the working day (11:30 A.M., 2 P.M., 4:30 P.M.), using rectangular bitemporal, bifrontal, and fronto-mastoidal lead electrodes 2 cm^2 in area (symmetrically on the left and right sides).

The following parameters of the REG were analyzed: duration of the whole rheowave, the period of filling and the systolic phase (in msec), the anacrotic and catacrotic amplitudes (in $d\Omega$), and the angular coefficient of the anacrotic front. Statistical analysis of the data was carried out on the Minsk-22 computer.

EXPERIMENTAL RESUTLS

It will be clear from Table 1 that the initial values of the temporal and amplitude-temporal parameters of the REG for bitemporal and bifrontal leads were similar ($P < 0.05$). They were much smaller for the

Department of Work Physiology and Industrial Psychology, Sverdlovsk Institute of National Economy.
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TABLE 1. Dynamics of Rheoencephalographic Indices during Working Day (top line shows bitemporal leads, bottom line bifrontal)

REG indices	Mean values of initial M ±m and change relative to initial value			
	9 A.M.	11:30 A.M.	2 P.M.	4:30 P.M.
Duration of rheowave (in msec)	811±18	+80	−5	+24
	820±19	+32	−18	+34
Period of filling (in msec)	256±3	+7	−4	−1
	254±3	+4	−1	0
Systolic phase (in msec)	305±4	+2	−12	−4
	302±3	+5	0	−2
Anacrotic amplitude (in dΩ)	0,62±0,03	+0,04	+0,09	+0,02
	0,77±0,03	+0,04	+0,06	+0,02
Catacrotic amplitude (in dΩ)	0,50±0,02	+0,03	+0,04	+0,03
	0,68±0,03	+0,04	+0,01	0
Anacrotic angular coefficient (in conventional units)	3,42±0,28	+0,26	+0,30	+0,10
	3,58±0,30	+0,14	+0,48	+0,26

fronto-mastoidal leads ($P < 0.05$). Values of the anacrotic and catacrotic amplitudes were significantly higher in the bifrontal and fronto-mastoidal leads ($P < 0.001$ and $P < 0.01$ respectively); they did not change substantially, and they remained higher by a statistically significant degree throughout the working day.

In the bitemporal REG, 2.5 h after the beginning of mental work an increase in the duration of the period of filling was observed ($P < 0.05$), the values of which at this stage of mental activity were the highest of all those recorded for this parameter using local leads. In the left fronto-mastoidal lead, an increase in duration of the filling period also was observed ($P < 0.01$). No changes were found in the amplitude and amplitude-temporal indices of the REG.

After mental work for 5 h, there was a marked decrease in all temporal parameters of the bitemporal and left fronto-mastoidal REG: the filling period ($P< 0.001$, $P < 0.001$) and systolic phase of the REG ($P< 0.01$, $P < 0.01$). The latter was significantly lower than its initial value ($P < 0.01$ and $P < 0.05$, respectively). Against this background an increase in the anacrotic amplitude of the bitemporal REG was observed. This rose steadily and became significantly higher than its initial value 5 h after the beginning of mental activity ($P < 0.01$). These changes corresponded to stability of the amplitude values of the catacrotic phase of the bitemporal REG.

Toward the end of the working day, the rheographic parameters tended to return to their original level, but in this case a sharp decrease took place in the level of correlation between amplitude characteristics of the bitemporal REG, where a weak positive correlation appeared after mental activity lasting 7-8 h (values of the coefficients of correlation corresponding to the order of recording were 0.87-0.76-0.81-0.15).

These results suggest that before the beginning of mental activity, an inequality in distribution of the blood flow exists in the anterior regions of the brain. In the frontal regions there is higher level of blood filling which develops at once and which is adequate for sustaining the mental work lasting 7-8 h. This stability of the indices of high pulse blood filling is also characteristic of the hemodynamics of the cerebral hemispheres, especially the right. In the temporal regions the state of preparedness for mental work is characterized by lower levels of blood filling than in the frontal regions, and in the course of the working day it shows marked fluctuations.

The comparatively low level of blood filling of the temporal regions is probably inadequate, and subsequently it increases, as is shown after 2.5 h by an increase in the duration of the period of filling the vessels with blood, and later by an increase in amplitude of the rheoencephalographic wave. The increase in level of the hemodynamics of the left hemisphere 2.5 h after the beginning of mental activity is the result of an increase in the blood filling time.

These fluctuations in temporal and amplitude parameters of the REG, giving indirect evidence of temporal and volume regulation of the pulse blood filling, correspond closely to each other, for close correlation relationships are observed between the filling time and the systolic phase of the REG, and also the

the anacrotic and catacrotic amplitudes of the rheowave. This coordination between the blood supply of the frontal regions is stable throughout the working day. However, when assessing the relationship between the parameters of the bitemporal REG, it is important to note that after mental activity for 7-8 h, changes occur in the process regulating the volume of blood filling the temporal regions, a process which takes place against the background of initial values of the bitemporal REG indices.

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