ASSESSMENT OF THE HUMAN REGIONAL CEREBRAL BLOOD FLOW BY VENOUS OCCLUSION RHEOPLETHYSMOENCEPHALOGRAPHY

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The possibility of using the method of venous occlusion rheoplethysmoencephalography (RPEG) for assessing the degree of change of the cerebral blood flow (CB) in the various zones of the cerebral hemispheres of the clinically healthy person during various functional loads was demonstrated. The change in CB is calculated as a percentage of its initial value. By means of venous occlusion RPEG evidence was obtained that CB is increased (by 114%) in the central-parietal region of the left hemisphere during movement of the right hand and reduced (by 45%) during acoustic stimulation. In the neighboring (temporal) zone the changes in CB were different in character.

KEY WORDS: *Venous occlusion rheoplethysmoencephalography; cerebral blood flow.*

Normal brain activity is known to be accompanied by a redistribution of the cerebral blood flow (CB) to correspond to the functional mosaic of the cortex and subcortical structures [2, 3, 9]. It has also been shown that during pathological changes of brain function this relationship is disturbed [7, 12, 13]. Both qualitative and quantitative methods are used to investigate the zonal CB and its relationship to the functional state of the brain under clinical and experimental conditions [6, 11, 12, 13, 16]. Most of these methods require an operation. The demand for a harmless, continuous, and prolonged method of investigation of the cerebral hemodynamics is satisfied by a rheographic method, namely rheoencephalography (REG). However, this method gives no indication of the level of the blood supply to the brain. The most promising technique from this point of view is rheoplethysmography (RPG), which reflects slow waves of impedance which correspond to changes in the total blood volume in the region investigated [8]. To study the cerebral hemodynamics RPG is used as a qualitative method [1, 17]. However, for investigating the peripheral blood flow (in the forearm) RPG has also been used successfully to estimate the velocity of the blood flow. For this purpose venous occlusion is used and velocity is expressed in ohms per minute [5].

In the investigation described below the possibility of using a technique of rheoplethysmoencephalography (RPEG) for quantitative comparison during the study of responses of the cerebral blood flow was studied during changes in the functional state of the brain.

For this purpose venous occlusion was used, as in the method of orbital plethysmography [4]. As a first step the indices of venous occlusion RPG and the plethysmograms of the forearm and orbit of the eye were compared and data obtained for correlation between values obtained by the two methods [5].

EXPERIMENTAL METHOD

RPEG was recorded from the two regions simultaneously on a San'ei polygraph with the aid of a four-channel rheograph of 4-RG-1A type, by means of which the slow component can be recorded from the position of the "0-500" frequency switch and the additional two-channel

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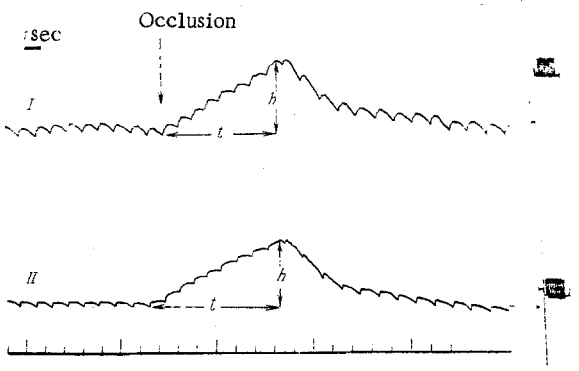

Fig. 1. Simultaneous recording of RPEG from two regions of the left cerebral hemisphere, with application of venous occlusion to the neck: I) central-parietal; II) temporal region; h) height; t) time of elevation of rheoplethysmographic wave.

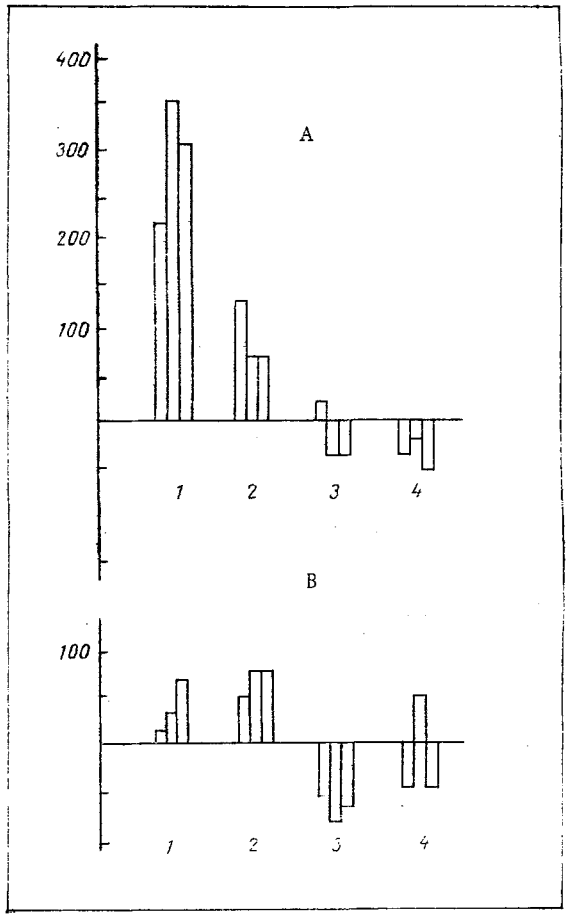

Fig. 2. Changes in intensity of local human CB in neighboring zones during different function tests: A) central-parietal region; B) temporal region. 1) Movement of contralateral upper limb; 2) speech articulation; 3) acoustic stimulation (tone); 4) listening to text. Columns represent individual observations.

dc amplifier. Frontomastoid [10] leads and partial leads — central-parietal (CP) and central-temporal (CT) — in accordance with the scheme for arrangement of electroencephalographic electrodes [15] were used. Venous occlusion was carried out by Votchal's method [4]: The venous outflow was temporarily stopped by raising the pressure in a cuff applied to the neck to 30-40 mm Hg. The intensity of the cerebral blood flow (ICB) was calculated by an equation identical with that used in the calculation for the peripheral venous occlusion RPG [5] and expressed in units of resistance per minute:

$$\text{ICB} = \frac{h}{t} \cdot k \cdot 60,$$

where k is the sensitivity of the rheograph (in ohms/mm). The subject performed function tests appropriate for the motor cortex: movement of the contralateral limb and speech articulation. The ICB also was measured during acoustic stimulation (by a tone of 70 dB) and while the subject listened to a text, interrupted by choosing and counting words.

The scheme of the experiment was as follows: At least three occlusion measurements were made, before the tests, during the function test, and for 1-2 min after its end. The change in CB as a result of the function test was estimated in percent relative to its initial value.

Investigations were carried out on 30 clinically healthy persons.

EXPERIMENTAL RESULTS

The value of short-term venous occlusion as the stimulus was determined for each subject. The EEG was recorded parallel with the RPEG. The intensity of the orienting reaction to short-term venous occlusion in the neck was judged from depression of the alpha rhythm on the EEG. As a rule occlusion was not accompanied by changes in the EEG with effect from the second application. The degree of informativeness of the indices of hemispheric and regional venous occlusion RPEG during the various function tests was analyzed.

For this purpose frontomastoid leads and central-parietal leads of the RPEG (left hemisphere) were compared while the subject moved the upper limb contralateral to the hemisphere studied. Under these circumstances, as the records of hemispheric RPEG showed, the changes in ICB (by 20% on average) were not significant. When central-parietal leads (CP) were used ICB in response to movement was increased on the average by 114% (σ = 12%).

The indices of the regional RPEG (central-parietal and temporal leads) were then compared during loads appropriate or inappropriate for the motor cortex. Changes in the local CB in two neighboring zones of the brain were discovered to be different in degree. Performance of a motor test (Fig. 2) by the subject led to an increase in the local CB, in this case by 350%. Speech articulation also was accompanied by an increase in local CB in this same zone (by 120%). In the neighboring (temporal) region changes in local CB during movement of the upper limb were of the same sign but were much less marked — at the most by 60%. Application of an acoustic stimulus caused CB in the motor area to fall. In the temporal zone under these circumstances an increased CB was recorded.

In all subjects CB in the motor cortex increased during movement on the average by 114 ± 12 % and it decreased by 45 ± 10 % during acoustic stimulation. In the neighboring (temporal) area the changes in blood flow were different in character as regards intensity or direction.

The method of venous occlusion regional RPEG can thus be used to estimate changes in the intensity of the local CB in individual zones of the cerebral hemispheres during loads that disturb the functional state of the brain. This method can also be used to compare the degree of these changes in neighboring brain zones and for corresponding purposes in clinical neurology.

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A RAPID TEST OF LIVER MORPHOLOGY AND FUNCTION

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For the rapid and simultaneous determination of several vitally important parameters of the state of liver tissue the vital dye neutral red was injected into the portal vein. The morphological state of the tissue, the adsorptive power of the liver cells, the efficiency of the microcirculation of the blood, and the pH shift were determined in histological sections cut from part of the piece of liver taken for investigation. From the other part of the piece of liver tissue the dye was extracted and the total quantity of dye adsorbed was determined.

KEY WORDS: *Adsorptive power of the liver; microcirculation of blood; intravital staining.*

In some cases it is important to obtain rapid information on various parameters of the state of the liver tissue. For example, if the patient is on the operating table and the extent of further surgical procedures has to be determined, when faced with the problem of suitability of cadaveric or preserved liver for transplantation, and in various other clinical situations. Combined investigation of a number of different indices of the state of the liver is also important in experimental investigations of the physiology and pathology of the organ and its responses to various exogenous and endogenous factors. This is particularly true of ischemia of the liver [2].

There is no description in the literature of a method whereby indices of the state of the liver such as morphological changes, adsorptive power, efficiency of the microcirculation of the blood, and the pH shift can be estimated simultaneously. As a rule to study each of these parameters separate methods are used [1, 7, 8], and this is naturally time consuming and not always practicable.

The technique devised by the writers enables all the indices mentioned above to be estimated by the use of a small piece of liver tissue after preliminary injection of the vital

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