EFFECT OF HEMODYNAMIC AND OTHER FACTORS ON THE RHEOENCEPHALOGRAM (REG) DURING REGIONAL PERFUSION OF THE HEAD

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Experiments with perfusion of a dog's head by means of an artificial circulation apparatus showed that the amplitude of the rheoencephalogram (REG) depends on the stroke volume. The pulsating character of the blood flow is of decisive importance for formation of the RÉG waves. If it is replaced by a continuous flow of equivalent magnitude, the REG waves disappear. The amplitude of the REG waves increases with an increase in electrical conductivity and temperature of the perfusion fluid.

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Some aspects of the origin of the RÉG and its dependence on systemic and regional hemodynamic factors have been inadequately studied. Gollan and co-workers [3,4], who carried out regional perfusion of a dog's head by means of an artificial circulation apparatus (ACA), established that the amplitude of the REG waves depends on the stroke volume of the heart. These workers did not study the influence of other hemodynamic factors.

We have investigated the effect of a pulsating blood flow and changes in the stroke volume, arterial pressure (AP), and electrical conductivity of the perfusion fluid on the REG.

EXPERIMENTAL METHOD

Experiments were carried out on 10 dogs weighing 10-15 kg, anesthetized with hexobarbital.

The arterial cannula of the ACA was inserted into the arch of the aorta through the left ventricle or subclavian artery. Insertion of the arterial cannula into the carotid arteries [4] is undesirable because this interrupts the blood flow into the vertebral arteries and reflex influences from the receptors of the arch of the aorta. The descending aorta and the aorta near its orifice were ligated. The blood was drained through the venous cannula of the ACA, inserted into the superior vena cava. To prevent leakage of blood along collaterals into the systemic circulation, a second venous cannula was inserted into the inferior vena cava. Because of the great importance of the biological activity of erythrocytes in determining the difference in electrical conductivity between liquid and solid tissues [2-5], fresh heparinized blood from a donor dog was used for perfusion.

Two pairs of lead electrodes 1.5 cm in diameter, fixed symmetrically on both sides (beneath the eye and in the parieto-occipital region) were used to determine changes in the blood flow in the left and right cerebral hemispheres. This method, in our opinion, reflects changes in intracranial impedance better than the method of Gollan and Namon [4]. For simultaneous recording of the rheogram (RG) of the carotid artery, tin-anodized copper foil electrodes measuring 1.5 × 2.5 cm were fixed to the exposed carotid artery in the neck at a distance of 3 cm apart. The REG was recorded by means of a Rheovar II 2-channel apparatus. The AP was measured through a catheter inserted into the right carotid artery.

After formation of an isolated regional blood flow and switching on the ACA, the heart was stopped by a weak electrical discharge. Stable saturation of the blood with oxygen was ensured by the oxygenator of the ACA.

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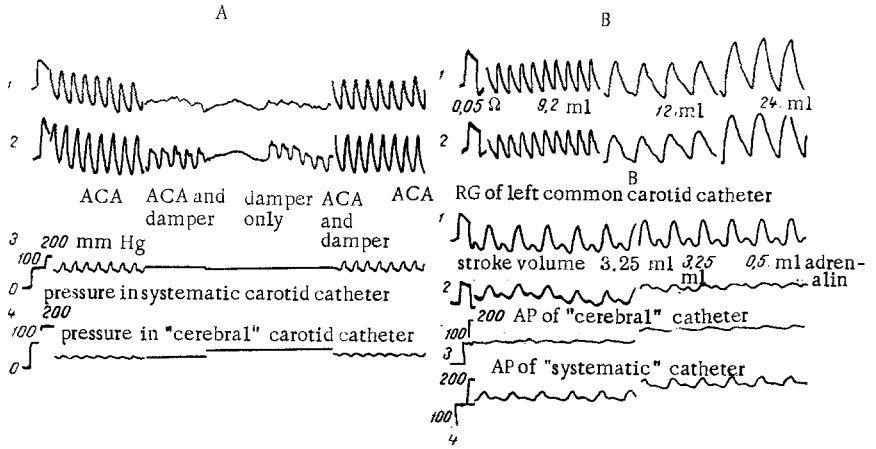

Fig. 1. Relationship between REG and pulsating character of blood flow (A), changes in stroke volume (B), and tone of cerebral vessels (C). A: 1) REG of right hemisphere; 2) REG of left hemisphere; 3) AP in "systemic" carotid catheter; 4) AP in "cerebral" carotid catheter. B: 1) REG of right hemisphere; 2) REG of left hemisphere. C: 1) REG of left common carotid artery; 2) REG of left hemisphere; 3) AP in "cerebral" carotid catheter; 4) AP in "systemic" carotid catheter. Explanation in text.

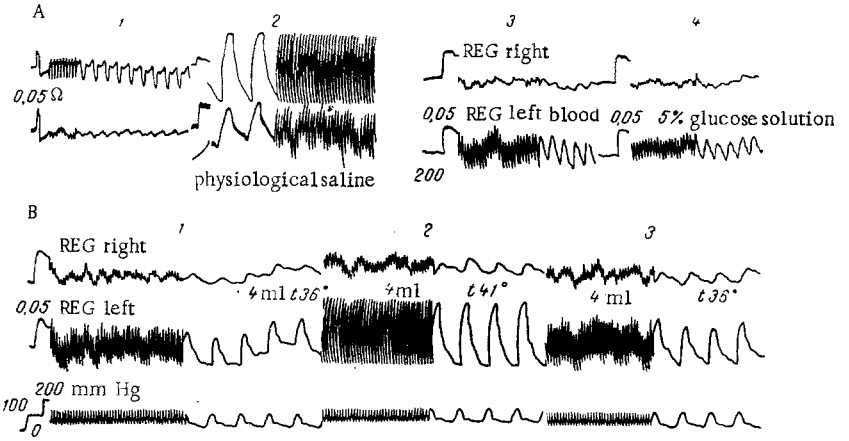

Fig. 2. Effect of changes in electrical conductivity of perfusion fluid on REG. A: 1) Perfusion with distilled water (top curve, RG of left common carotid artery, bottom curve REG of left hemisphere); 2) perfusion with isotonic sodium chloride solution (curves the same as in A, 1); 3) perfusion with blood of donor dog, and 4) perfusion with isotonic 5% glucose solution (in 3 and 4 top curves denote REG of right hemisphere, bottom curve REG of left hemisphere). B: perfusion with blood of donor dog at temperature of 36° (1), 41° (2), and 36° (3) (top curve denotes REG of right hemisphere, middle curve REG of left hemisphere, bottom curve AP in "systemic" carotid catheter).

The effects of premedication and anesthesia on the REG are due mainly to changes in respiratory activity [1, 6]. Since in our experiments respiration was stopped and blood oxygenation was stable, all changes in REG in the experiments were interpreted as results of experimental tests.

EXPERIMENTAL RESULTS

Inclusion of a damper in the arterial tube of the ACA caused partial loss of energy of the pulse impact, the pulse fluctuation diminished, and the amplitude of the REG began to fall. When the pulsating blood flow was replaced by an equivalent nonpulsating flow (the blood entered the arterial cannula from the raised damper under the influence of gravitational force) but the mixture volume and AP remained unchanged,

the pulse waves of the REG disappeared (Fig. 1, A). With an increase in stroke volume the amplitude of the REG waves increased, while with a decrease in stroke volume the amplitude decreased (Fig. 1, B).

Since an increase in output of the ACA was accompanied not only by an increase in stroke volume, but also by an increase in the systemic AP, it was not clear whether the changes in amplitude of the REG waves were dependent on changes in the stroke volume or on changes in the AP. To examine the effect of changes in the systemic AP in isolation against a background of constant output of the ACA (stable stroke volume), adrenalin was injected into the blood. The amplitude of the REG waves thereupon was reduced (Fig. 1, C). This was evidently due to the fact that, besides an increase in systemic AP, there was also a considerable increase in impedance of the cerebral vessels.

During perfusion with distilled water, with lower electrical conductivity than blood and brain tissue, pulse fluctuations in impedance continued to be recorded, although the direction of the pulse waves was distorted (Fig. 2, A, 1).

If the distilled water was quickly replaced by isotonic sodium chloride solution the negative REG waves became positive. Fluctuations of impedance during perfusion with sodium chloride solution were greater than during perfusion with water, although the output of the apparatus remained constant (Fig. 2, A, 2).

During perfusion with 5% glucose solution a decrease in amplitude of the REG waves was observed by comparison with its value during perfusion with blood, but the pulse waves remained positive (Fig. 2, A, 3-4).

Against the background of a stable stroke volume, with elevation of the temperature of the blood used for perfusion an increase in amplitude of the pulse waves was observed, while a decrease of temperature led to a corresponding decrease in amplitude (Fig. 2, B).

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