METHODS

A THERMOELECTRIC METHOD FOR STUDYING THE CEREBRAL CIRCULATION IN UNANESTHETIZED DOGS

A. M. Blinova and N. M. Ryzhova

From the Laboratory of Physiology and Pathology of Respiration and Circulation (Head – Professor M. E. Marshak) Institute of Normal and Pathological Physiology (Director – Active Member of the Acad. Med. Sci. USSR V. N. Chernigovskii) Acad. Med. Sci. USSR, Moscow

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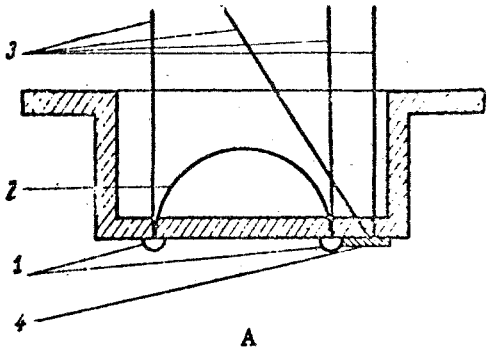
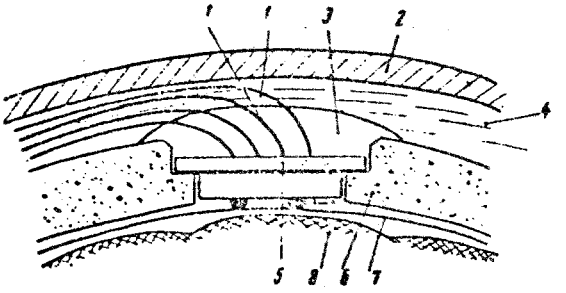
Cerebral circulation in animals has been studied chiefly in acute preparations under general anesthesia. This type of experiment cannot be relied upon to give a true picture of changes in the cerebral circulation. It is therefore very important to develop a method which makes it possible to observe the circulation in the brain under normal conditions.

In deciding upon a method, the following points must be considered: 1) the method must not disturb the normal blood and fluid circulation, 2) there must be no trauma to the brain and 3) the cranium must remain hermetically sealed.



A

Fig. 1A. Diagram of thermoelectrode. 1) Thermocouple junctions; 2) constantan; 3) copper leads; 4) nickel disk.



B

Fig. 1B. The thermoelectrode in the skull (diagrammatic). 1) Leads; 2) skin; 3) filling of dental cement; 4) muscles; 5) thermoelectrode; 6) bone of skull; 7) dura mater; 8) brain.

The thermoelectric method satisfies these conditions best, since there is no damage to the tissues, no resistance to blood flow, and the thermoelectrode can be inserted so that the cranium remains hermetically sealed.

In view of these considerations, we implanted the thermoelectrode in the intact dura. Control experiments showed that in this position, the thermoelectrode registers changes in blood flow in both the dura and the pia mater. The thermoelectrode is so placed that it is possible to measure changes in the blood flow in the meninges immediately under it.

To record changes in venous flow, the electrode was placed on the dura over the superior sagittal sinus.

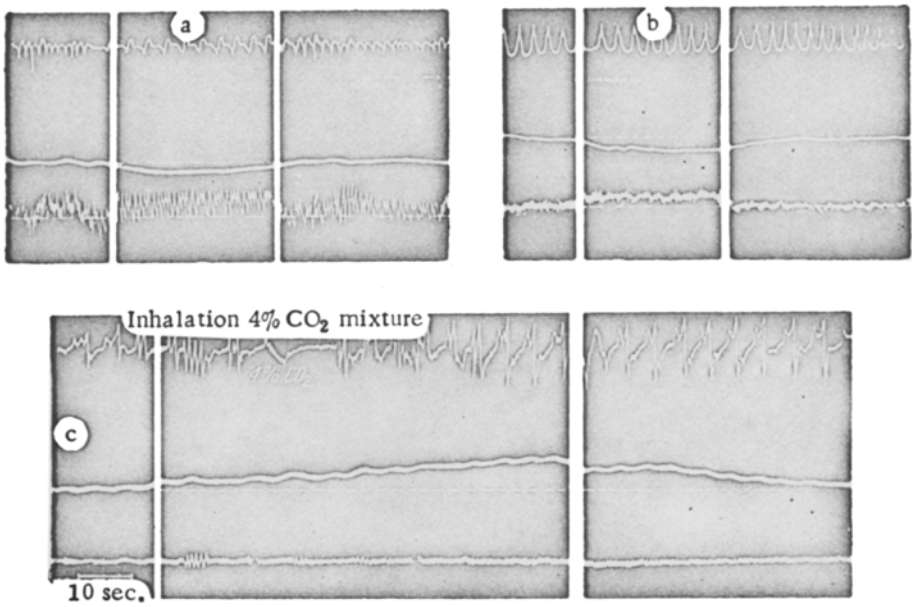


Fig. 2. Effect of compressing one of the common carotid arteries on rate of flow of blood (a) in superior sagittal sinus and (b) in the cerebral meninges. (c) Effect of breathing 4% CO_2 on rate of blood flow in the meninges.
Curves from above downwards; respiration, rate of blood flow in cerebral meninges (b, c), rate of flow of blood in sagittal sinus (a), blood pressure. Dotted line – initial rate of blood flow.

As investigations in this laboratory have shown, the thermoelectric method can be used only to make a qualitative estimate of increase or decrease of blood flow. To measure cerebral circulation in unanesthetized animals, a special flat thermoelectrode was used, as proposed by M. E. Marshak [1], this being a modification of A. Noyons' method [2]. The flat thermoelectrode consisted of a round hollow flat bottomed vessel with flanged edges made of plexiglass. The width of the edge was 1 mm, the diameter of the vessel – 5-6 mm, height – 1.5-2 mm. The copper-constantan junctions and the nickel disk for heating one of them were mounted at the bottom of the vessel. The leads from the junctions and the nickel disk were taken out through the cup and fixed to a flanged edge. The cavity of the vessel with the leads from the junctions and the nickel disk was filled with liquid plexiglass.

To apply the thermoelectrode to the skull an opening was cut which precisely fitted the thermoelectrode (Fig. 1B). The thermoelectrode was then placed in the aperature, with the junctions close up against the dura, and the edge lying in an area countersunk into the bond (see Fig. 1B). The space over the thermoelectrode was filled with a dental cement. For the cement to hold the thermoelectrode was filled with a dental cement. For the cement to hold the thermoelectrode firmly, the bond at the site of operation must be dry. Therefore during the operation it is essential to arrest hemorrhage from the bone, and to be meticulous in drying the edge of the hole.

The leads from the thermoelectrode are covered in polyvinyl chloride insulation, carried under the skin and brought out to the surface 5-6 cm below the occipital protuberance. After the operation a special collar was fixed to the neck to guard the leads from damage. Four animals with inserted electrodes were kept under constant observation for 7-19 days after the operation. In one of them the thermoelectrode was inserted with the junctions in the parietal region and in the region of the superior sagittal sinus.

We found that the thermoelectrodes were adequately sensitive to changes in cerebral circulation (Fig. 2). Comparison of changes in the cerebral circulation in the superior sagittal sinus and in the parietal region showed that in both cases the change is in the same direction for a given stimulus (Fig. 2, a and b).

SUMMARY

The use of a thermoelectric method for the study of blood supply to the brain in unanesthetized dogs is described. Modified flat Noyons' thermoelectrodes were placed on the intact dura mater in the parietal region or in the area of the superior sagittal sinus. 4 dogs with such thermoelectrodes were under continuous observation from 7 to 19 days following the operation. It was established by these experiments that in these conditions the thermoelectrodes are quite sensitive to the changes of the blood flow of the brain. These changes in the superior sagittal sinus and in the parietal region are similar when the same influence is exerted.

LITERATURE CITED

[1] M. E. Marshak, Biull. Eksptl. Biol. i Med. 43, 1, 121-122 (1957).*

[2] A. K. M. Noyons, N. V. Westernrijk and J. Jongbloed, Arch. Neer. de Physiol. 1936, Vol. 21, pp. 377-432.

* Original Russian pagination. See C. B. Translation.