REACTION OF THE INTRACEREBRAL VASO-CAPILLARY NETWORK OF RABBITS TO CLOSED HEAD INJURY IN ONTOGENESIS

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Closed head injury sustained by a 5 day-old rabbit in the period of active formation of the vascular system of the brain sharply inhibits the process of proliferation of cerebral capillaries. The deficiency of capillaries developing during the first hours and days of life after trauma is not subsequently made good, as a result of which the density of the vaso-capillary network in the cerebral cortex of experimental animals is lower than in control animals of the same age. Damage to the process of formation of the vaso-capillary network is most severe in the parts of the brain receiving the trauma.

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In earlier papers [7-9] we described severe disturbances of the development of the vascular system on the brain surface after closed head injury. In this paper data are given relative to the response of the intracerebral capillary network of the developing brain to closed head injury.

EXPERIMENTAL METHOD

Experiments were carried out on 32 young rabbits aged 5 days, at a time of active formation of the vascular system in the brain (especially of the venous system), when the cerebral capillaries undergo active proliferation, the density of the intracerebral capillary network increases, and so on [1-3, 5, 6, 10]. Trauma to the occipital region of the skull was produced by a weight falling down a vertical tube [9]. The blood vessels of the brain of the experimental animals 1 h and 6 and 21 days after trauma and of control animals of the same age were injected intravitally with a 3% solution of gelatin in ink. After cooling for 2-3 h the brain was removed from the skull and fixed in 10% formalin solution. The blood vessels were studied in whole brain preparations under the MBS-2 binocular microscope. The density of the intracerebral capillary network was determined in series of paraffin sections 10μ in thickness.* The number of growing capillaries was determined in sections treated by Kosovskii's method [3, 4] in 100-400 fields of vision under magnification of 400 times; the mean for each 100 fields of vision was determined.

EXPERIMENTAL RESULTS

Closed head injury to a 5 day-old rabbit sharply depresses capillary proliferation throughout the brain, but especially at the site of trauma. The number of growing capillaries in the occipital lobes 1 h after trauma was 3 times smaller than in the control. In parts away from the site of trauma the number of growing capillaries was reduced by 2.5 times. A few days after trauma, resumption of proliferation of the cerebral capillaries was observed. Comparison of the intensity of capillary proliferation in the occipital lobe 1 h and 6 days after trauma showed that the number of newly formed capillaries in each hundred fields of vision rose by about 3.5 times. However, determination of the density of the capillary network in the occipital lobe indicates that, despite an active increase in the number of new capillaries, the deficiency developing in the first few hours after trauma is not made good completely during the next 6 days. Although the mean values of capillary density in the groups of control and experimental animals were about equal, namely 666 and 654 μ,

*The density of the capillary network is taken to be the length of capillaries present in 1 mm^3 of brain substance.

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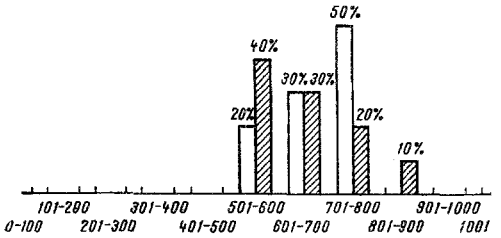

Fig. 1. Fluctuations in density of the capillary network (in μ along abscissa) in different parts of the occipital cortex of control 11 day-old rabbits (unshaded columns) and experimental animals of the same age surviving 6 days after trauma inflicted at the age of 5 days (shaded columns).

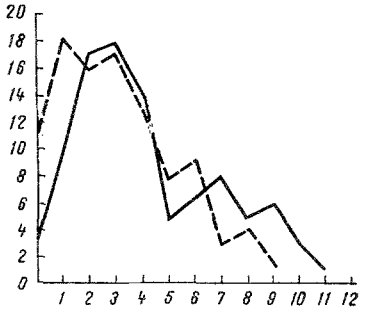

Fig. 2. Decrease in number of growing capillaries in various parts of occipital cortex after closed head injury. Continuous line, control 11 day-old rabbits; broken line, experimental 11 day-old rabbits surviving 6 days after trauma inflicted at age of 5 days. Abscissa, number of growing capillaries per field of vision; ordinate, number of fields of vision.

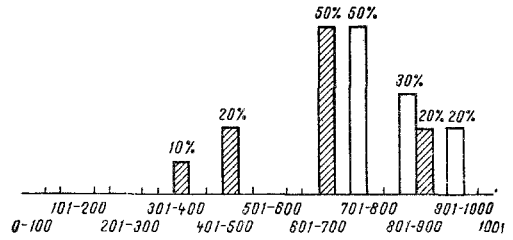

Fig. 3. Decrease in density of capillary network (in μ along abscissa) in different areas of the occipital cortex of control rabbits aged 26 days (unshaded columns) and experimental animals surviving 21 days after trauma inflicted at the age of 5 days (shaded columns).

variations in the distribution of capillaries in the occipital lobe of the experimental animals cannot be disregarded. For instance, whereas in control 11 day-old rabbits, a density of 601-800 μ was found for 8% of the areas, and only 20% of areas of the cortex had a density as low as 501-600 μ, in the experimental animals the proportion of areas with a density of 501-600 μ was twice as high, and areas with a density of 601-800 μ accounted for only 50% of the occipital cortex. Characteristically, the network was denser than normally in some parts of the occipital cortex of the experimental animals (Fig. 1). In rabbits surviving 6 days after trauma, no capillary proliferation had taken place in a considerable number of areas of the occipital cortex; the number of areas in which only one newly formed capillary had grown was twice as high. In the experimental animals the number of areas with 7-8 growing capillaries in each field of vision was 2-3 times smaller; more than 9 growing capillaries were not found in any area. In the vascular system of the occipital lobe of the control animals, from 9 to 12 capillaries had grown in 11% of cortical areas. The curve reflecting the course of proliferation of cerebral capillaries in the experimental animals was therefore shifted to the left along the abscissa; disturbance of the process was most marked at the site of trauma (Fig. 2).

Between the 11th and 26th day of life the intensity of capillary proliferation in the brain of the control animals fell considerably. In a rabbit aged 26 days, in each hundred fields of vision in the occipital lobe only 16 capillaries were growing, with 32 in the parietal lobe. This gradual decline in the intensity of the process was also characteristic of the experimental animals. For example, 21 days after trauma the number of growing capillaries in the occipital and parietal lobes was 12 and 32 in 100 fields of vision respectively. A study of the density of the vaso-capillary network in these lobes 21 days after trauma showed that with the passage of time, the loss sustained by the vascular system immediately after head injury and during the following days of life was not compensated. In experimental rabbits aged 26 days the mean density in the occipital lobe was 625 μ ($l = 620 \pm 90\mu$, $P = 0.68$), and in the controls 816 μ ($l = 820 \pm 70\ \mu$, $P = 0.68$). In the experimental rabbits, 80% of cortical areas had a density below 700 μ, while in the control animals no such areas were present and the density varied from 701 to 1000 μ (Fig. 3). The number of vessels in the parietal lobe 21 days after trauma also was sharply reduced. The mean density of the vaso-capillary network in the parietal lobe was 740 μ ($l = 740 \pm 65\mu$, $P = 0.68$), and in the controls 940 μ ($l = 940 \pm 70\mu$, $P = 0.68$). In the experimental animals, 60% of cortical areas in this region had a density below 800 μ, while in the control animals areas with a density higher than 800 μ were more numerous.

The results thus show that local closed head injury disturbs the development of the brain as a whole; the intensity of proliferation of the cerebral capillaries falls sharply, as a result of which the brain substance, especially at the site of trauma, contains fewer blood vessels than normally.

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