THE COLLATERAL LYMPHATIC CIRCULATION IN THE SMALL INTESTINE OF THE DOG AFTER DESTRUCTION OF THE PREMOTOR AREA OF THE FRONTAL LOBE OF THE BRAIN

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We tried to discover what effect injury to the cortex of the frontal lobe in the premotor area has on the collateral lymphatic circulation. We know of no morphological investigations of this problem in the literature.

V. M. Ugryumov observed vascular reactions (changes in blood pressure, reactions of cutaneous and rectal vessels) after injury to the skull and brain. These were especially noticeable in patients with injuries of the frontal and parietal areas. The role of the trophic function of the brain cortex was shown in the work of B. I. Bayandurov [3, 4] and V. E. Chechetkin [6]. Destruction of the cortex of birds and various mammals inhibited or stopped the growth of the animals.

In accord with the data of F. G. Popov [5], the healing and regeneration of wounds is different in character if the frontal lobe is injured than when there is no such injury. In E. A. Asratyan's investigations [1, 2] and those of his associates, the necessity for consideration of the role of the brain in plastic processes is indicated.

EXPERIMENTAL METHOD

We conducted 3 series of experiments on dogs. In the first series of 14 dogs, we attempted to discover the effect of destroying of the entirety of the cortex of the frontal lobe in the area of the premotor zone on the uninjured lymphatic system (the lymphatic system of the small intestine was investigated from several hours to 12 months after the intervention on the cortex). In the second series, we studied the effect of destroying the entirety of the premotor zone of the frontal lobe on the collateral lymphatic circulation. With this goal, 2-3 weeks after the operation on the brain, the mesenteric lymph nodes were removed in 13 dogs. By this means, we disrupted the lymphatic drainage from the intestine and mesentery; the collateral lymphatic circulation should have developed after this. The lymphatic systems of the dogs' intestines in this series were studied from 7 days to 11 months after the second operation. Data from the second series of experiments were compared with the results of the third, control, series in which the collateral lymphatic circulation of 20 dogs was studied without interference with the brain.

We carried out lymphangiography on live anesthetized animals (15-20 focussed shots and 4-5 general ones in each experiment). A 50% solution of collargol was used as the contrast medium.

The radiological method of studying the lymphatic systems of the living animals allowed us to trace the dynamics of the development of the collateral lymphatic circulation.

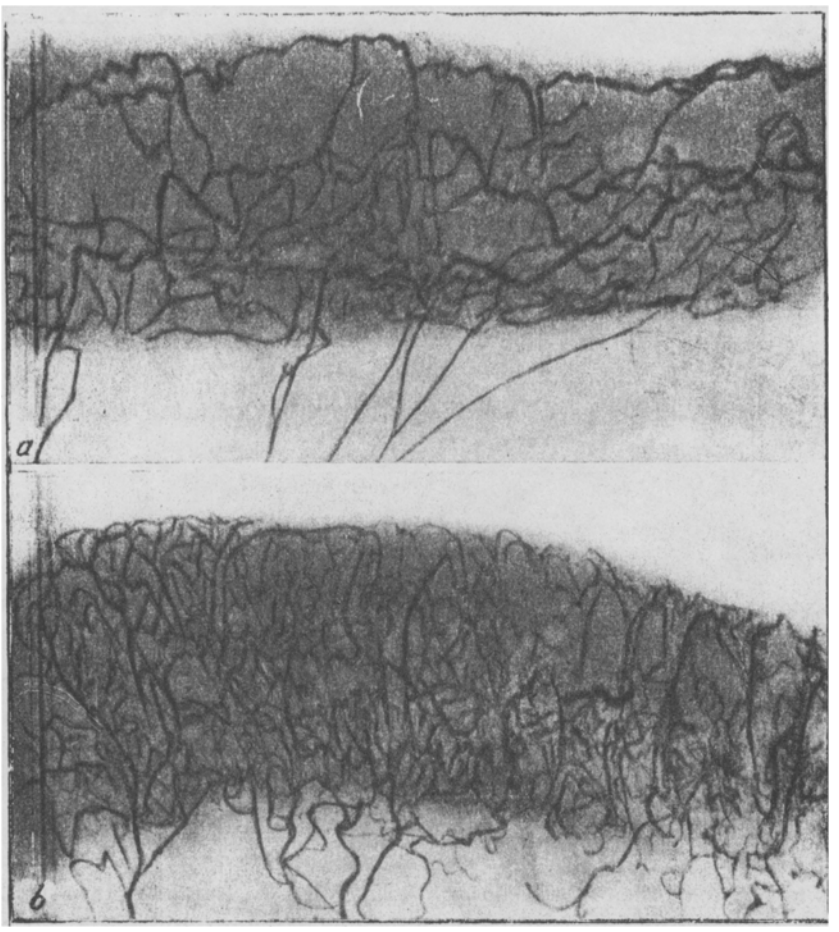

Figure 1. Collateral lymphatic circulation 7 days after removal of the mesenteric lymph nodes.
The network of lymphatic vessels on the intestine, an indicator of obstruction and disruption of the drainage, is thicker and more extensive in dogs with destroyed frontal lobes (b) than in dogs with intact brains (a).

EXPERIMENTAL RESULTS

Destruction of the entirety of the frontal lobe of the cortex in the area of the premotor zone did not produce any characteristic changes in the uninjured lymph channel of the small intestine and mesentery. Only an insignificant dilation of the lymph channel, on the verge of normality, could be detected. When the collateral lymphatic circulation developed, at which time there was an increased demand on this system, the effect of the destruction of the premotor zone was more clearly demonstrated.

Seven days after all basic mesenteric efferents were interrupted and the mesenteric nodes were removed from dogs in the second series, the lymphatic network of the intestine [Fig. 1, (a)] and the perivascular junctions in each neurovascular bundle were filled. Drainage was effected, for the most part, by the perivascular vessels which surrounded the branches and main stem of the superior mesenteric artery (the perivascular vessels fill irregularly, weakly, and only in the peripheral part of the neurovascular bundle under normal conditions). Definite indications of insufficient drainage were observed, such as the protracted retention of the contrast medium

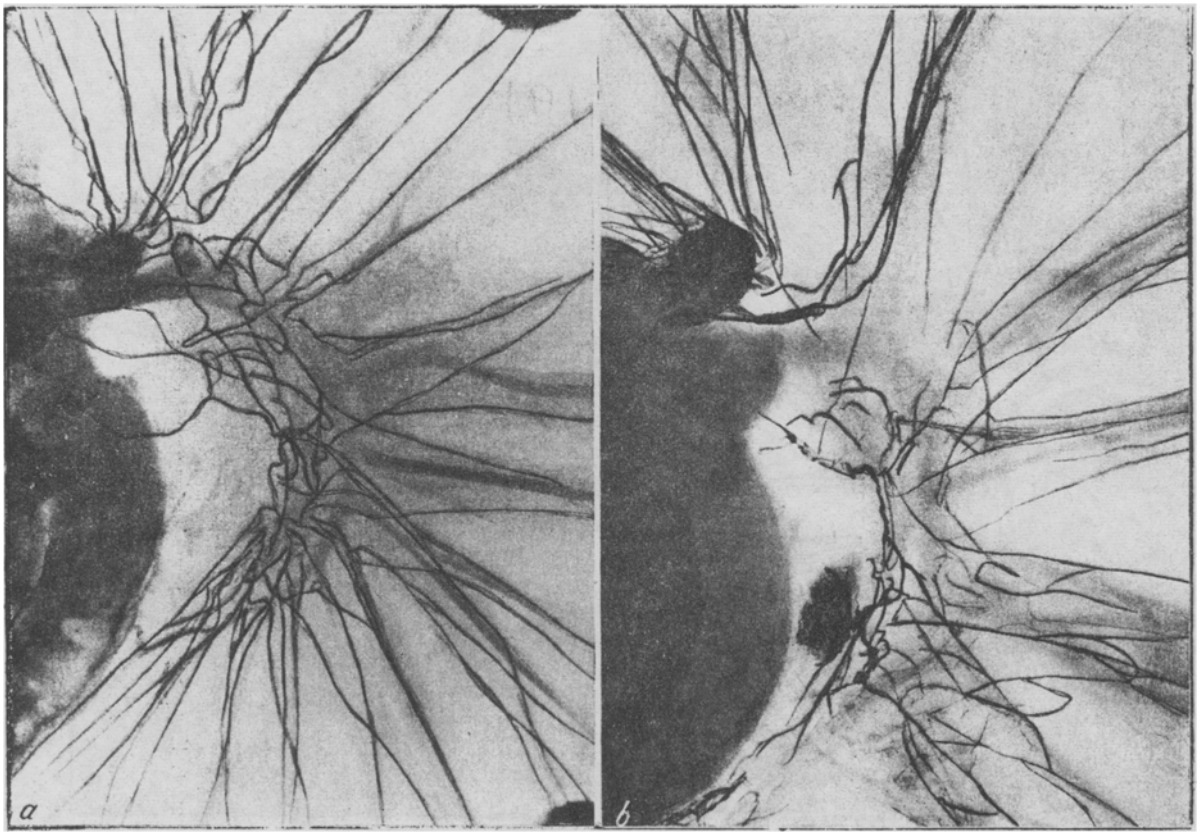

Figure 2. Collateral lymphatic circulation 4 months after removal of the mesenteric lymph nodes. Anatomoses of lymphatic vessels in place of the removed conglomeration of mesenteric nodes developed better in dogs with intact brains (a) than in dogs with destroyed frontal lobes (b).

in the vessels and network [Fig. 1, (b)] , as well as the presence of a well-developed system of valves. Dogs in the control series showed less pronounced dilation of the vessels and signs of insufficient drainage after the same period of time.

Two to three weeks later, the development of anastomoses was observed in dogs of the second series; the signs of obstruction decreased.

After a month, dogs of the same series showed anastomoses between the primary channels and the perivascular vessels of the superior mesenteric artery only in the region of the first 4-5 neurovascular bundles. Anastomoses were still absent in the distal portion of the mesentery. The contrast medium was retained in the interrupted vessels here for an extended period. As a result of the small number of anastomoses in the mesentery, tortuous drainage routes developed from the subserous lymphatic network of the intestine, extending caudally.

After the same length of time, the anastomoses in the control series of dogs were better developed, the contrast medium left the vessels more rapidly, the network on the intestine hardly appeared.

After two months, fewer anastomoses were observed in dogs with destroyed frontal lobes than in the control animals, and then only in the proximal half of the mesentery. In the distal part, junctions and drainage routes of a different type were formed than in dogs of the control series: 1) between branches of the efferents of adjacent neurovascular bundles; these anastomoses created a tortuous drainage route in the mesentery parallel to the mesenteric vein (long paths); and 2) a large-mesh network of zigzag anastomoses on the intestine in the caudal half, draining into the lymph nodes of the large intestine.

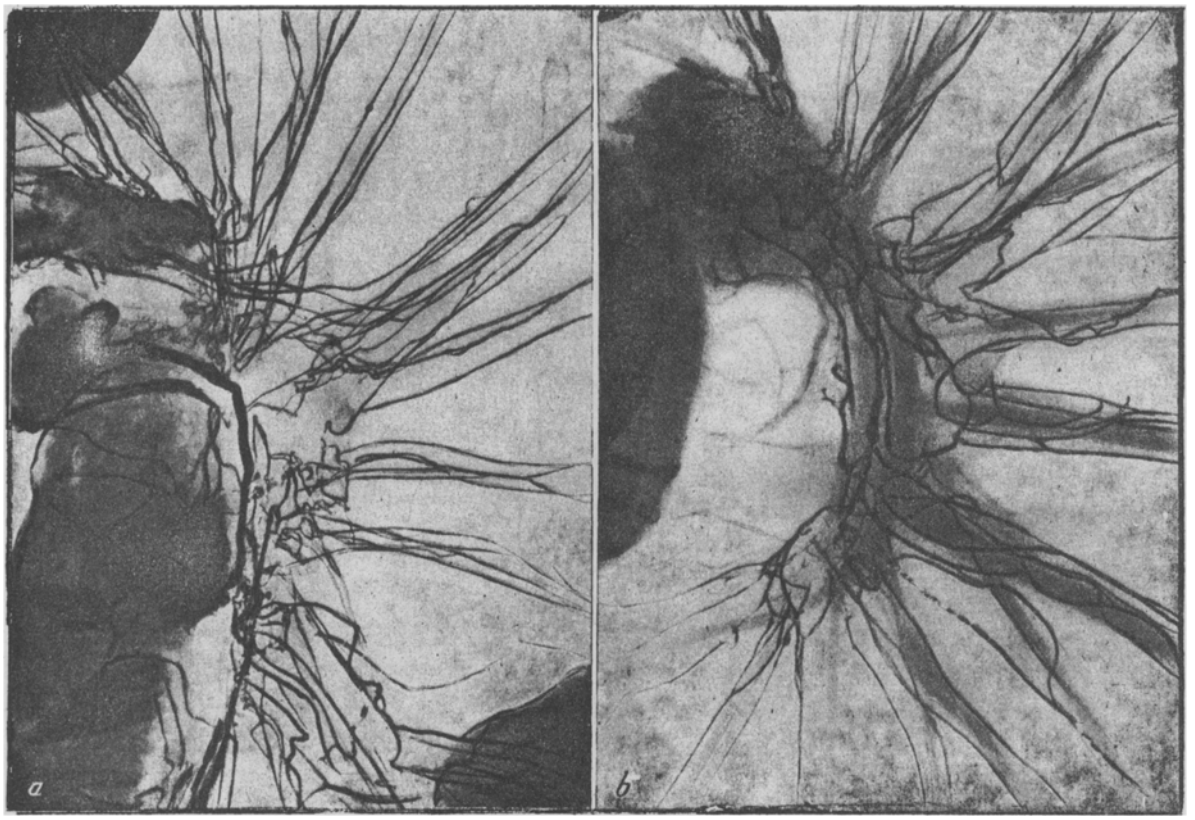

Figure 3. Collateral lymphatic circulation 5 months after removal of the mesenteric lymph nodes. Dogs with intact brains showed multiple perivascular vessels and basic efferents which formed straight, short anastomoses at the root of the mesentery (a); dogs with destroyed frontal lobes have fewer perivascular vessels and their basic efferents formed long, tortuous collaterals on the sides (b).

After 3-4 months, further formation of the long tortuous paths described before could be seen in dogs of the second series in the distal portion of the intestine [Fig. 1, (b)] and in the mesentery [Fig. 2, (b)], which were not observed in dogs of the third series [Fig. 2, (a)].

After 5-6 months, the lymphatic drainage of the control animals was fully reestablished; both the perivascular vessels and the basic efferents took part in it [Fig. 3, (a)]. The latter showed multiple anastomoses with the perivascular vessel at the intestinal edge of the mesentery, in the middle, and at its root. The perivascular vessels were more numerous and wider; they served as a kind of basic drainage path. At the same time, there were fewer anastomoses in the distal part of the mesentery in the dogs with injured frontal lobes [Fig. 3, (b)], and along the intestine and in the mesentery, the long drainage routes were filled in an unusual direction. A peculiarity of the picture was the comparatively weak participation of the perivascular vessels in lymphatic drainage, their small diameter and number. Consequently, the destruction of the premotor zone of the frontal lobe of the brain changed the functional as well as the morphological picture of the collateral lymphatic channel. Dogs which had been subjected to the brain operation soon showed marked dilation and insufficiency of the lymph channel. Development of anastomoses and reestablishment of the disrupted lymphatic drainage occurred slowly and less completely. As a result of insufficient drainage, long tortuous paths flowing in unusual directions were formed. The ability of the lumphatic system to regenerate and adapt to new conditions was less apparent.

Correlating the data obtained with the indications in the literature, one can suppose that the observed dilation of the vessels was caused by the disruption of the coordination between the cortical and subcortical vasculo-motor centers. The inhibition of the reestablishment of the damaged lymphatic drainage occurs as a result of the disruption of the trophic function of the brain and lowered regenerative ability.

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