THE PECULIARITIES OF THE COURSE OF ANAEROBIC INFECTION IN RATS POSSESSING DAMAGED CEREBRAL CORTICES

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In the analysis of the mechanisms accompanying the development of gas gangrene, we succeeded in establishing the special role played by the afferent muscle nerves in the pathologic inflammation.

Altering the functional state of the nerve tissue in the muscle (novocainization) and interrupting the reflex arc both on the afferent and efferent sides (severing the posterior and anterior spinal cord roots) enabled us, in a considerable number of animals, to prevent infection, while at the same time the control animals invariably died of gas gangrene.

There was the problem of clarifying the role of the central nervous system during the course of fatally infecting animals with anaerobic microbes.

The findings which we will discuss below touch particularily upon the development of anaerobic infection under conditions when the animals had had extirpated either limited or large areas of the cerebral cortex.

EXPERIMENTAL METHODS

The work was done on white rats. The material for causing infection was the standard suspension of the septic vibrion culture 59, containing 6 billion microbes per 1 cc. This microbic mixture was dissolved just before the experiment, in a sterile physiological solution of table salt in a ratio of 1:1000. To the diluted microbial culture was added an equal volume of 5% solution of calcium chloride. In order to produce the infection 0.1 cc. of the resulting mixture was introduced into the pad muscles of the experimental animals.

In the animals, before infection, the cerebral cortex was extirpated from sites accessible to operation (frontal, parietal, occipital). In order to determine, during the course of the experiments, the importance of the length of time from the moment of the operation to the moment of infection, the animals were infected at various intervals after operation - after 3, 10 and 30 days.

Altogether 70 animals were used (35 control and 35 experimental). After 3 days 10 of the operated animals were infected, after 10 days 12, and after 30 days, 13 animals. Simultaneously as each operated animal was infected, a control animal was infected. The results obtained can be seen in Table 1.

As can be seen from Table 1, in the experimental group in which the animals were infected after wide extirpation of cerebral cortical areas, there was a marked decrease in the mortality when compared with the controls. This difference is especially marked in the group of animals infected 10 days subsequent to the cortical extirpation: of the 12 animals operated on, only one died , while from the control group 11 died.

In this fashion, it seems that wide cortical extirpation alters the relation of the animal to the progression of the gas gangrene.

TABLE 1

Characteristics of the Course of Anaerobic Infection When Large Areas of the General Cortices are Extirpated

Type of interference	Time of infection after interference (in days)	No. of animals	Experimental results	
			No. dead	No. survived
Large areas of cerebral cortex removed	3	10	5	5
Control		10	9	1
Large areas of cerebral cortex removed	10	12	1	11
Control		12	11	1
Large areas of cerebral cortex removed	30	13	4	9
Control		13	10	3

TABLE 2

The Peculiarities During the Course of Anaerobic Infection after Cerebral Cortical Damage

Character of intervention	Time interval of infection after interference (in days)	No. of exptl. animals	Experimental results	
			No. dead	No. survived
Removal of limited areas of cortex	3	10	4	6
Trauma to cortex by doing sections	3	10	3	7
Opening the skull and cutting the dura mater	3	10	6	4
Control		10	9	1

TABLE 3

The Peculiarities During the Course of Anaerobic Infection after Damage to Limited Areas of the Cerebral Cortex of one Cerebral Hemisphere

Experimental conditions	Time interval of infection after interference (in days)	No. of exptl. animals	Experimental results	
			No. dead	No. survived
Removal of small area of left hemisphere. Left extremity infected.	3	34	18	16
Removal of small area of left hemisphere. Right extremity infected.	3	33	7	24
Control		34	22	12
Removal of small area of left hemisphere. Left extremity infected.	10	35	20	15
Removal of small area of left hemisphere. Right extremity infected.	10	35	17	18
Control		35	20	15

For a clarification of the causes of the lowered mortality among the experimental animals there was needed a determination of the meaning of the operational trauma in relation to the general condition of the central nervous system, which apparently is manifesting itself in the reaction of the organism to the microbial irritant.

As is known, I. P. Pavlov [7] constantly pointed out that the extirpation not only traumatizes large areas of the cerebral cortex but also removes the functions of these areas, and also markedly alters the functions of the entire nervous system, which might have an influence on the response of the organism to various irritants acting upon it. Analagous conclusions based upon their work were drawn by A. D. Speransky [9], K. M. Bykov [1], A. G. Ivanov-Smolensky [5] and others.

It might be thought that under the conditions of our experiments it is this very fact that plays a vital role in the changed reactions of the organism to the infection. In order to clarify this question, the following experiments were undertaken.

In some animals, instead of removing large cerebral areas only limited portions were removed; in others the extirpation of brain regions was substituted by cerebral traumatization (sections). A mere opening of the skull and sectioning of the dura mater without traumatizing brain tissues served as controls.

Experiments were also done to clarify what influence trauma of only one cerebral hemisphere has upon the reactive capabilities of the organism in resisting the infections introduced into the muscles of the extremity, both upon the side of the damaged hemisphere and on the opposite side. These results are tabulated in Tables 2 and 3.

Analysis of the obtained results, as can be seen, shows that all our operative interventions, just as was seen in the removal of wide cortical areas, are characterized by a marked slowing of the infectious process, as can be seen to one or another degree depending on the extent of the inflicted trauma.

These experiments (Table 2) also showed that this altered response by the animal varies and is limited by definite time intervals and that it is increased the greater the inflicted trauma. Thus, in the experiments with wide removal of cortical areas the changed reaction of the animals manifests itself a month after the operation, while at the same time local damage to the cortex shows up within the nearest few days; with this we were able to establish that the indicated condition of the animals can be observed not only with removal of areas of the cerebral cortex, but also by cutting the hard coverings of the brain without traumatizing the cortex.

Deserving of attention are the experiments with limited removal of the cerebral cortex of one hemisphere and in the infection of animals, in some cases in the muscles on the extremity of the affected side and in others in muscles of the opposite extremity (Table 3). In these experiments we were able to observe that limited trauma to one hemisphere influences the response of the organism to infections only on the side opposite the damaged hemisphere. With this, mortality to gas gangrene is lowered only in the first few days after operative interference and by the 10th day the difference has vanished.

We have conducted experiments which show a changed reactivity of the organism (within the concrete conditions of our work) that is not connected with the fact of the absence of the cerebral cortex, but is a result of the operative trauma to the brain, producing changes in the functional state of the central nervous system of the nature of a protective inhibition.

For the appearance of foci inhibition in wounded regions in cases of skull - brain injury there are findings obtained by M. P. Berezin, I. D. Richter and V. M. Ugryumov (1949). These authors established that these foci affect the periphery, lowering the reactivity of peripheral nerve systems, as a result of which repeated trauma to the brain (operations on the inflicted wounds) does not lead to considerable changes of the chronaxie and electrosensitivity of the nerves in the muscles of the extremities.

Experimental data [2, 11] show that trauma to the brain disturbs subordination; the findings of a number of other authors [3, 4, 6, 9, 10, 12] also speak of the subordinating influences upon the periphery by action taken on the cerebral cortex.

Thus, our experiments have shown that the functional condition of the central nervous system plays a very large role in the reactive capacities of the organism and in the response to natural infectious toxic agents.

LITERATURE CITED

[1] Bykov, K. M. The Cerebral Cortex and Internal Organs* (Moscow-Leningrad, 1949).

[2] Verzilova, O. V. Lazarev, V. G., Magnitsky, A. N. Subordination in the Nervous System and its Meaning to Physiology and Pathology* (Moscow, 1948) pp. 110-122.

[3] Volokhov, A. A. and Gershuni, G. V. Russ. Fiziol. Zhur. 16, 1, 131-137. (1933).

[4] Zhukov, A. P. and Kharitonov, S. A. Arkh. Biol. Nauk. 38, 1, 137-147 (1935).

[5] Ivanov-Smolensky, A. G. Essays on the Pathophysiology of Higher Nervous Activity* (Moscow, 1952).

* In Russian.

[6] Lazarev, V. G., Levitina, G. A. and Magnitsky, A. N. Subordination in the Nervous System and its Meaning to Physiology and Pathology* (Moscow, 1948) pp. 100-109.

[7] Pavlov, I. P. Complete Collection of Works* (Moscow-Leningrad, 1947) Vol. 4.

[8] Speransky, A. D. Elements of Medical Theory* (Moscow, 1936).

[9] Uflyand, Yu. M., Theory and Practice of Chronaxie* (Leningrad, 1941).

[10] Perelman, L. B. and Shteinbakh, E. E. Neuropatol. i Psikhiat 7, 9, 33-49 (1938).

[11] Yudina, E. F. Subordination in the Nervous System and its Meaning to Physiology and Pathology* (Moscow, 1948) pp. 123-139.

[12] Bourguignon, G., La chronaxie chez l'homme (Paris, 1923).

* In Russian.