SEQUELAE OF DECORTICATION IN DOGS WITH LATERAL HEMISECTION OF THE BRAIN STEM

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In our previous research [7, 8], we showed that lateral hemisection of the brain at the level of the pons varolii in dogs is accompanied by profound disturbances of the motor functions. After one or two weeks the dogs are unable to stand and walk, the neck and trunk are curved towards the side opposite the section, and the extensor tone in the ipsilateral limbs and the flexor tone in the contralateral limbs are strongly increased; involuntary automatic movements of the contralateral limbs are observed. The functions disturbed in consequence of hemisection are gradually restored in the course of 1-2 months to such an extent that the animals subjected to operation are externally indistinguishable from healthy animals; only a more detailed examination revealed certain motor disturbances. The subsequent removal of the cortex of the hemisphere opposite the hemisection causes repeated and profound disturbances of the motor functions in the dogs which were restored after the first operation. The functions disturbed a second time as a result of removal of the cortex of the hemisphere opposite the hemisection are again gradually restored (in the course of 1-1 ½ months), but not completely; even a long time after the second operation (as much as 7 ½ months) certain motor disturbances may still be observed, especially during the performance of complicated motor actions by the animals.

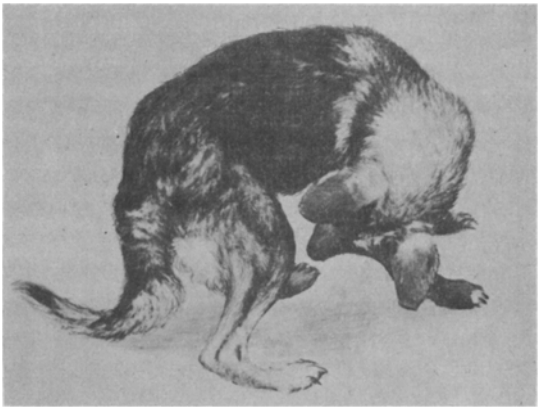
It could thus be postulated that the functions disturbed in consequence of decortication of one cerebral hemisphere are restored by means of the undamaged cortex of the second hemisphere. In order to investigate this problem more fully, in four dogs with hemisection of the brain stem at the level of the pons and subsequent unilateral decortication, we removed the cortex of the second cerebral hemisphere.

METHOD

Experiments were carried out on four adult dogs in which, a few months before operation, a left-sided hemisection of the brain stem had been carried out at the level of the pons, followed by removal of the cortex of the right cerebral hemisphere. The cortex of the second, left, hemisphere was removed after all possible restoration of the functions impaired by the previous operation had taken place. In all cases the cerebral cortex was extirpated surgically.

RESULTS

The experiments showed that removal of the cortex of the second hemisphere caused profound disturbances of the previously restored motor functions. The animals lost their ability to stand and walk, their movements became chaotic and incoordinated, and the dogs often adopted unnatural poses, tucked their head beneath them and thrust their right forepaw on their head. It could be seen that increased tone was present in the extensors of the limbs on the same side as the section, and in the flexors of those on the opposite side.



The dog Alpha, 6 ½ months after decortication of the second cerebral hemisphere. (Hemisection of the brain stem was performed on April 2, 1956, decortication of the first hemisphere on May 22, 1956 and of the second on September 24, 1956.)

In the postoperative period all the dogs displayed great restlessness, performed haphazard movements of all the limbs and struck the walls of the box in which they were kept with their head; it therefore became necessary to keep the animals in a sleeping condition by means of hypnotic drugs.

In the course of time some degree of restoration of the deranged functions of these animals after operation took place.

At the end of the first month, the dogs began to raise themselves on all four limbs. During this action it could be observed that the motor function of the hindlimbs was

disturbed to a far greater degree than that of the forelimbs. On standing, the animals' paws were placed widely apart, the head was placed low and the trunk often flexed laterally; the dogs quickly lost their balance and fell.

At the end of the second month, the dogs now rose from a recumbent position fairly quickly, but could only stand for a short time, and then lost their balance and fell. The gait was not regained at all by the dogs after removal of the cortex of both hemispheres and hemisection of the brain stem at the level of the pons varolii. In one dog, Malyshka, rare stepping movements were observed, but for the greater part of the time she stood immobile, with the head hanging down. Another dog, Alpha, sometimes took one or two steps backwards or moved the hindlimbs for a few steps in a circle to the right, thus turning around the forelimbs; the forelimbs under these circumstances also made stepping movements but a much slower rate than the hindlimbs. In a third dog, Bobik, flexion of the right hindlimb was extremely pronounced, so that the animal could hardly stand; no stepping movements by this dog were observed.

No subsequent improvement in the motor activity of the animals was observed, and the general picture for each animal a long time after the operation of removal of the cortex of the second hemisphere remained unchanged: the animals could not walk and their supporting functions remained grossly deranged (see figure).

After removal of the cortex of the second cerebral hemisphere, all the animals showed the presence of trophic ulcers, trophic changes in the skin accompanied by desquamation and falling out of the hair; scratches and abrasions constantly developed, caused by the animal's haphazard movements. It must also be mentioned that after bilateral decortication the dogs became extremely restless; an attempt to keep them in any one position caused severe motor restlessness, which prevented the more detailed examination of the dogs by the use of special methods.

Thus the removal of the cortex of the second cerebral hemisphere in dogs after preliminary lateral hemisection of the brain stem led to profound and prolonged disturbances of the locomotor and supporting functions; with the passage of time, the righting reflexes and the supporting functions were to some extent restored, as a result of which the animals became able to raise themselves from recumbency and to stand for a short time, although they could not walk.

According to the literature [1, 4, 6, 10, 11], on the second day after the two-stage removal of the cortex of both hemispheres, dogs can eat unaided, and on the 3rd-5th day they begin to walk; G. P. Zelenyi [4] even describes coordinated "play" movements in a decorticated young dog. In dogs decorticated after preliminary lateral hemisection of the brain stem at the level of the pons varolii, in contrast to decorticated dogs with no other injury to the central nervous system, the supporting and locomotor functions remained considerably disturbed and were only partially restored. On the other hand, in dogs with lateral hemisection of the spinal cord at different levels after bilateral decortication, standing and walking were not regained regained at all [1, 5].

The cerebral cortex thus plays an important part in the restoration of the functions disturbed in consequence of lateral hemisection of the brain stem at the level of the pons varolii; but the part it plays is smaller in this case than after lateral hemisection of the spinal cord. The divisions of the central nervous system lying below the level of section – such as the medulla oblongata and the lower part of the pons – evidently take part also in the compensation of the deranged functions.

The experimental data thus obtained on the participation of the cerebral cortex in the restoration of functions deranged by injury to the brain stem are in agreement with clinical observations. In the presence of pathological focus in the brain stem, the cerebral cortex undertakes, by means of the formation of new conditioned reflex connections, a complex and manifold reorganization of the functions of the nervous pathways and centers in compensation for the disturbed activity of the brain stem [2, 3, 9].

The findings obtained are also in agreement with E. A. Asratyan's main views on the leading role of the cerebral cortex in adult higher animals in the compensatory adaptations developing in the course of organic lesions of the nervous system.

SUMMARY

Removal of the cortex of the second hemisphere in dogs after hemisection fof the brain stem at the level of the pons and subsequent unilateral decortication provoked deep disturbances of the reestablished motor functions. With time the righting reflexes and the locomotor functions in these animals showed a certain degree of recovery, while standing and walking functions still remained considerably disturbed. Thus in adult animals the cerebral cortex plays an important role in the restoration of the motor functions, deranged as the result of lateral hemisection of the brain stem at the level of pons varolii.

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