The Interplay Between Cerebral Hemispheres and Cerebellum in Relation to Tonus and Movements*

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There is a system of checks and balances at various levels of the brain and spinal cord which is responsible for the well modulated tonus and the coordinated movements of the head, trunk, and extremities that characterize normal behavior. The balance between the discharges from the cerebral cortex at one end of the arc, and the cerebellum at the opposite end is demonstrated in the present paper. The material is the result of studies of elective lesions made in over 300 operations on the macaque and 4 surgical procedures on man. The conclusions drawn from this study are illustrated best by the presentation of 2 selected cases, 1 in the monkey and the other in man.

Experimental Case

On June 10, 1959 a left posterior parietal and suboccipital craniotomy was performed on a macaque (Monkey 4711). The left occipital lobe was elevated, the tentorium was incised, and, with cautious retraction of the cerebellar hemisphere, the left superior cerebellar peduncle and adjoining areas were sectioned. Postoperatively the animal's head deviated toward the left side. The left pupil was smaller than the right and there was a tendency for the eyes to drift upward. Hypotonicity was more marked in the left upper than in the left lower extremity.

For 6½ months the animal could not stand but lay at the bottom of the cage. The head was tilted with the chin to the left. Both lower extremities were hypotonic and the left upper extremity displayed less tonus than the right upper one. When the animal was placed on her left side on the bottom of the cage she would immediately roll over to the right side and use the left extremities to push herself about in a circle. During this interval the animal never was able to regain a standing position or to walk.

A right frontoparietal craniectomy with subtotal hemispheric cortectomy was performed on Jan. 7, 1960. Because of the animal's precarious condition, parts of the amygdala, the hippocampus and the medial surface of the temporal lobe were not excised, but the operation was terminated rapidly to save the animal. She is pictured 3 weeks postoperatively still in essentially the same condition as prior to the second operation (Fig. 1). However, she improved gradually over a period of 4 months and tonus was regained in the left upper extremity and the left lower extremity. The animal regained her feet, walked, and tried to use the wall as a crutch by supporting her right side against the wall (Fig. 2).

When the animal was sacrificed, the gross specimen exhibited the right cortectomy with the residual cortex which included part of occipitoparietal cortex and part of the temporal lobe, the

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**Fig. 1.** Monkey 4711. 7 months after left superior cerebellar pedunculotomy and 3 weeks after the second procedure, right hemispheric cortectomy. The animal still was unable to stand or walk but lay on her right side using her left extremities to push herself about in a circle on the floor.
Interplay between Cerebrum and Cerebellum

Amygdala, the hippocampus and a small veil over the temporal horn of the right lateral ventricle (Fig. 3). Inspection of the lateral wall of the 4th ventricle demonstrated that the left superior cerebellar peduncle had been sectioned (Fig. 4).

Selected microscopic sections demonstrate the location and extent of the lesions responsible for the alteration in the animal's tonus and movement. The plane through the abducens-facial level of the pons reveals the most extensive part of the left cerebellar lesion (Fig. 5) and shows the degree of destruction of the brachium conjunctivum and the other homolateral cerebellar peduncles. On the left, the spinal tract of V is involved particularly, as is also the major portion of the medial lemniscus. It should be emphasized that the sensory loss, including the proprioception from the body by the lesion in the medial lemniscus, will appear contralateral to the cerebellar lesion and therefore will not increase the ataxia on the side of the latter involvement. The degenerated right corticospinal tract is readily visible.

A microscopic section at the level of the N. XII shows the degenerated right corticospinal tract...