PARALYSIS IN FLEXION AND TREMOR IN THE MONKEY FOLLOWING CORTICAL ABLATIONS*

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(Received for publication May 9, 1944)

INTRODUCTION

Paralysis with flexion attitude, spasm and contracture in the lower extremities, is well known in injury or disease of the spinal cord. Clinically cerebral lesions inducing flexion paraplegia have been described by Demange,4 and others 1,6,10,11,12,13,14. The syndrome occurs with extensive degenerative cerebral disease, most frequently of arteriosclerotic origin. Marie and Foix11 and Alajouanine1 have emphasized lesions in the paracentral lobules and subjacent white matter. Verhaart13 has stressed lesions of the central gyri and frontal lobe, and, in one patient, attributed the flexion pattern to decerebration above the red nucleus.14 The lesions are often diffuse and Herman’s attempt to localize the significant one in his case was impeded by too numerous and extensive arteriosclerotic changes.6 This subject has been recently reviewed by Daniels2. Unilateral flexion paralysis sometimes results from capsular hemorrhage15 and Holmes and Sargent8 described flexion spasms of the legs in a number of patients with the sagittal sinus syndrome.

Few experimental observations have been recorded. Alajouanine1 produced paraplegia in flexion in the dog by bilateral, midline cortical ablations. Hines7 noted permanent shortening of the hamstring muscles following unilateral ablation of areas 4 and 4s in monkeys. Walshe16 correlated extensor tonus following cord injury with damage to the pyramidal tract, and flexor reflex exaggeration with more extensive lesions involving extrapyramidal tracts as well. Flexion of the extremities, however, is not remarkable following unilateral or bilateral seriatim ablations from area 6, the principal extrapyramidal region of the cortex. This paper describes the experimental production of flexion paralysis in monkeys by simultaneous extirpation of area 6 (including its mesial surface) bilaterally.

Tremor, which appeared also in these animals, has been previously noted as occurring in monkeys with bilateral lesions of area 69. The augmentation of the involuntary movements associated with cerebellar destruction5 and with basal ganglia lesions9 by additional removal of area 6 has been discussed.

MATERIALS AND METHODS

Four adult sooty mangabey monkeys (Cercocebus torquatus atys) were used in these experiments. Operations were performed by accepted neurosurgical techniques and postoperative

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observations were made daily at first and at intervals of two or more days as the animals' neurological status became more nearly static. Gross and microscopic examination of the nervous system was carried out post mortem.

This phenomenon of paralysis in flexion was observed, by chance, in an experimental study of spasticity. These four animals which developed flexion paralysis were compared with a group of other monkeys with cortical lesions elsewhere, which showed paresis,—either spastic or flaccid, without the flexor attitude in the lower extremities.17

EXPERIMENTAL DATA

Abstracts of the protocols of the experimental animals follow.

Experiment 1. (R.S. 28) Male sooty mangabey age ca. 4 yrs. (wt. 6.8 kg.). Bilateral ablation of areas 6 and 4s. Immediate flexion paralysis. Death on 2nd postoperative day from trauma.

Operation May 14, 1943. Under sodium amytal anesthesia a large bone flap was reflected and a bilateral ablation of area 6 and the greater part of area 4s was performed.

Postoperative Notes. 1st day. During the night the animal had opened the operative incision by pulling its head against the cage side and the bone flap had been displaced. It was quite drowsy and lay in its cage with legs and arms tightly flexed, grasping the cage side with both hands. The opening was repaired and sulfathiazole was dusted into the wound.

2nd day. The animal went rapidly downhill and died.

Autopsy. Lacerations of the pole of the right temporal lobe and of the left parietal cortex were found. There was no gross evidence of meningitis. The convolutions were somewhat flattened. Other organs were grossly normal.

Summary. Reflex grasp, paresis and flexion pattern appeared bilaterally immediately after operation. No other observations were possible because of postoperative cortical trauma.

Experiment 2. (R.S. 29) Male sooty mangabey (wt. 6.8 kg.). First operation: Bilateral ablation of areas 6 and 4s. Paresis in flexion and tremor of all four extremities. Second operation: Ablation of left areas 2, 5 and 7. Contralateral temporary diminution in spasticity.

First Operation May 20, 1943. A large bone flap was reflected and a bilateral ablation of area 6 and the anterior part of area 4s was performed.

Postoperative Notes. 2nd day. The animal lay on its belly with both thighs flexed, adducted and internally rotated. The knees were partially flexed. There was piloerection, immobility of the face, slowness of movement and reflex grasp in all extremities. A fine tremor accompanied movement.

4th day. There was little change. Voluntary movement was performed only grossly in the arms and was greatly impeded by reflex grasping. Posture was unchanged except that the animal was lying on its side. Resistance to passive extension was increased slightly in both legs; tremor continued.

Interval Note. On the 5th day alternating movements of the legs were performed when the animal was supported and dragged along the floor but these soon disappeared. It could neither stand nor walk and the flexed posture of the legs was maintained. Atrophy rapidly appeared in the legs. Knee jerks were equal and active and forced grasp and Rossolimo were present bilaterally. Resistance to passive movement was increased in all extremities but this was slight in the legs and on extension only. Tremor continued.

Second Operation June 2, 1943. The bone flap was reopened and areas 2, 5 and 7 were removed from the left side.

Postoperative Notes. 2nd day. Posture and movement were essentially unchanged. Resistance was met in trying to extend the legs and to flex and extend the arms. The resistance was more marked on the left side.

5th day. The animal lay on the floor of the cage and could neither stand nor sit up. Posture was unchanged. Resistance to passive manipulation was marked in all extremities and was most marked on the left side. Only grasping movements were performed by the hands.

8th day. There had been no change.