14160

Morphologic Effects of Poliomyelitis Virus upon Motor End Plates in the Monkey.*

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No report has been found of observations on the early morphologic disappearance of motor end plates and early appearance of ephemeral inclusion bodies in striped muscle coincident with or following shortly after the onset of paralysis in acute poliomyelitis in the monkey. The cellular and vascular reactions in the central, and in parts of the peripheral, nervous systems during the acute stages have been exhaustively studied.[1-11]

Methods. Motor end plates in the triceps, biceps brachii, and quadriceps femoris were studied in 8 monkeys, and in addition to these the gastrocnemius and tibialis anterior muscles in 7 monkeys, inoculated with poliomyelitis virus. Eight monkeys (*Macacus rhesus*) were chloroformed from 8 to 20 days after inoculation intracerebrally with 0.5 cc of 5% virulent cord-emulsion (Armstrong-Lansing strain of poliomyelitis virus).† Parts of each muscle were fixed and stained by different histologic technics. The best one for demonstrating the pathologic changes in the anatomic continuity of axis-cylinders, motor end plates, and striped muscle was a modified gold method,[12] followed by careful teasing of small pieces (2 x 5 mm) of the impregnated muscle. This report was limited to the findings obtained by the gold method. The brief protocol of monkey No. 490 (Kramer's series), from which photographs (Fig. 2 to 6) were made of differential nerve degeneration follows: intracerebral inoculation 2/14/43; rise of temperature 2/25/43; paralysis of fore limbs 2/27/43; paralysis of hind limbs, complete quadriplegia, chloroformed 3/3/43. Thirty selected muscles from both fore and hind limbs in 2 normal monkeys were prepared by the same gold method applied to the paralyzed muscles and used as controls. More than 2000 teased preparations of the innervation of different muscles were used in this study.

Results. The normal motor end plates (Fig. 1) varied from 15 to 30 μ, measured

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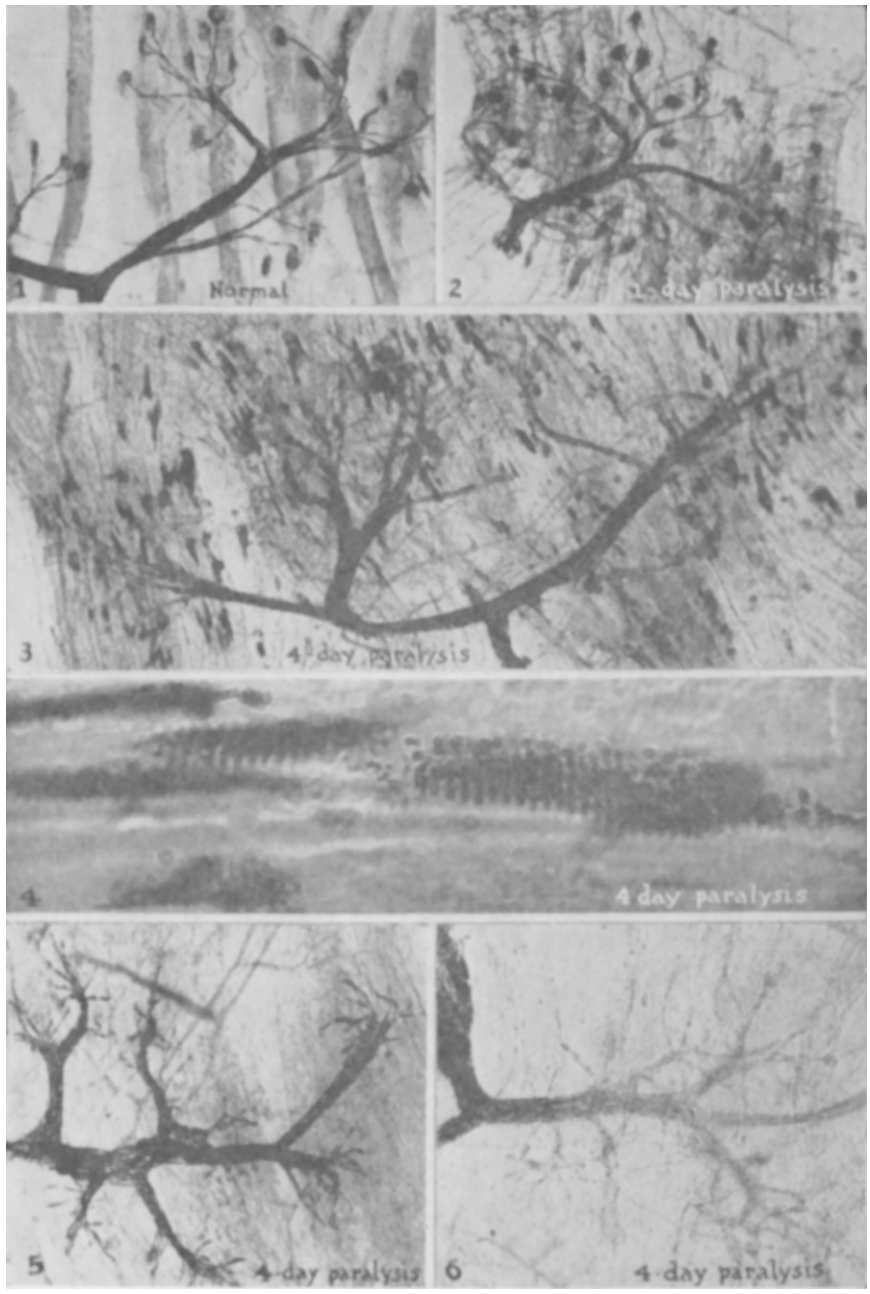

Photomicrographs, normal innervation, quadriceps muscle in the monkey, Fig. 1, × 70; innervation, quadriceps, 1 day after paralysis, Fig. 2, × 70; biceps brachii 4 days after paralysis: degenerating innervation has multiple masses of inclusion bodies in muscle fibers, Fig. 3, × 70, and Fig. 4, × 650; triceps 4 days after paralysis: total absence of motor end plates, Figs. 5 and 6, × 70.

in the longitudinal axis of the quadriceps muscle fiber. The dark and light muscle fibers were evident in the normal Fig. 1, but not in the paralyzed, Fig. 2, quadriceps muscle. Some end plates on the first day of paralysis were retracted in a ball-like mass, Fig. 2, with shortened axis-cylinders and intense affinity for gold; others were hypertrophied and granular with loss of definition; many plates were very small, granular, and had weak affinity for gold. About 20% of the motor plates were absent in the paralyzed muscle on the first day; whereas within 2 to 4 days about 50% of the end plates had disappeared. On the 4th day, many retracted axis-cylinders were completely denuded of end plates, Fig. 5, and had sharp or budlike ends in the triceps muscle. The rates of nerve degeneration were unequal in this muscle. Some trees of axis-cylinders had advanced granular degeneration and weak affinity for gold at their terminals, Fig. 6, near the zone of the absent end plates. Proximad, the same axis-cylinders had a normal morphology and strong affinity for gold. The direction of degeneration appeared to be centripetal from the end plates in many fields. The intramuscular blood vessels were congested, cuffed, and had more granules, with strong affinity for gold, in the lumen than the normal. Masses of inclusion bodies, Fig. 3 and 4, which varied in length from 10 to 85 μ, were found within many muscle fibers in 4 of the 8 monkeys (Kramer's series) killed from 1 to 4 days after the onset of paralysis. These auriphilous inclusion masses were composed of granules 0.1 to 2 μ and spheroid bodies 2 to 4.5 μ in diameter. Each isolated body was frequently surrounded by a halo. In many instances, the finer constituents were arranged in cross striations, Fig. 4, which were more intensely stained with gold than those of the muscle fibers. Care was taken to differentiate histologically these masses of inclusion bodies from sporidiosis. In 15,179 muscle fibers of the right biceps, monkey No. 490, these inclusion masses were found in 12,683 fibers near the zone of the disintegrating innervation. They have not been found in 30 muscles of 2 normal control monkeys nor in those after one week of paralysis. These ephemeral inclusion masses at the degenerating myoneural junction appeared to be characteristic, as far as this limited evidence goes, of certain unknown chemical reactions that occur at certain times during the early stages of experimental poliomyelitis within and near the degenerating innervation of muscles in some monkeys. This study will be continued on a large series of mice.

Summary. Coincident with and shortly following paralysis by poliomyelitis virus the following morphologic changes occur in the motor end plates: 1, disappearance of many end plates resulting in denervation at the myoneural junction; 2, ephemeral appearance of masses of inclusion bodies, some of which are cross striated, within and near the degenerating motor end plates; 3, differential rates of motor nerve degeneration; 4, degeneration beginning in the motor end plates and proceeding in a centripetal direction in the axis-cylinders of many motor nerves.