

CHANGES IN THE OSSEOUS SYSTEM OF MONKEYS AFTER NEUROSIS

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Several months after production of experimental neurosis in 4 monkeys, marked degenerative changes were found in the skeleton, and were particularly marked on roentgenograms of the spine and cranial bones.

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This paper describes the results of a roentgenologic study of changes in the osseous system of monkeys after production of an experimental neurosis.

EXPERIMENTAL METHOD AND RESULTS

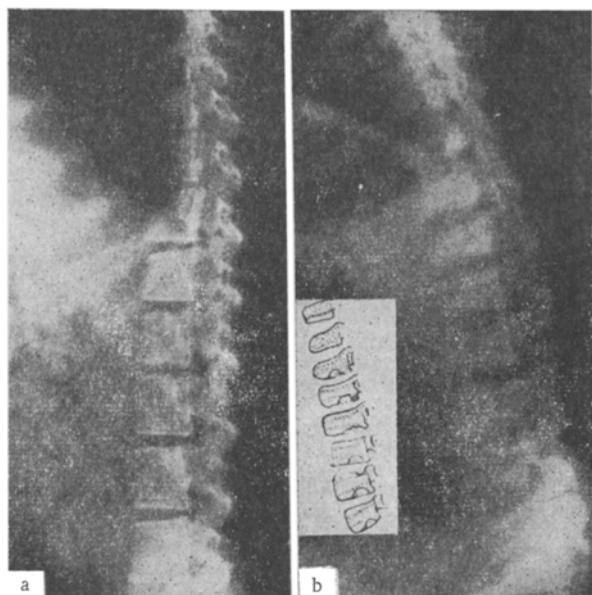


Fig. 1. Roentgenogram of lumbar and part of thoracic spine of the baboon Kastrop (male, aged 4 years 9 months)—normal for comparison (a), and roentgenogram of spine of monkey Mal'chik with diagrammatic representation (b): marked osteoporosis, considerable reduction in height of vertebral bodies, zones of reconstruction of bone tissue of vertebral bodies in the form of transverse bands of translucency alternating with bands of condensation, prolapse of nucleus pulposus seen as indentations on lower surfaces of vertebral bodies.

Experiments were carried out on 4 male baboons (Papio hamadryas aged 4-5 years (Antopol', Gelendzhik, Mal'chik, and Kolet). To study the state of higher nervous activity, conditioned motor food reflexes were formed in all the monkeys to a dynamic stereotype of acoustic and photic stimuli (positive and differential). Indices of the conditioned reflexes thus produced and the general behavior of the monkeys testified to the normal state of their higher nervous activity.

To produce a neurosis in the experimental animals, one of the methods customarily used for this purpose [6] in monkeys was selected. For a long time (several months) the monkeys were kept under conditions so that their rhythm of sleep and waking was disturbed at random (diurnal stereotype). This trauma to the central nervous system of the monkeys continued altogether for about 5 months and led to the development of a severe neurotic state in all the animals, with characteristic changes in their conditioned-reflex activity and general behavior [2]. After the end of neurosis-producing procedure and removal of the monkeys from their situation of conflict, observations were maintained on the general state of the animals for 1 year.

During the first 4-5 months after psychic trauma changes in higher nervous activity were particularly severe and profound. During the 6th-12th month of the postneurotic period, the state of higher nervous activity began to improve perceptibly, but conditioned-reflex activity and the general behavior of the monkeys were still definitely neurotic in character. An unusual

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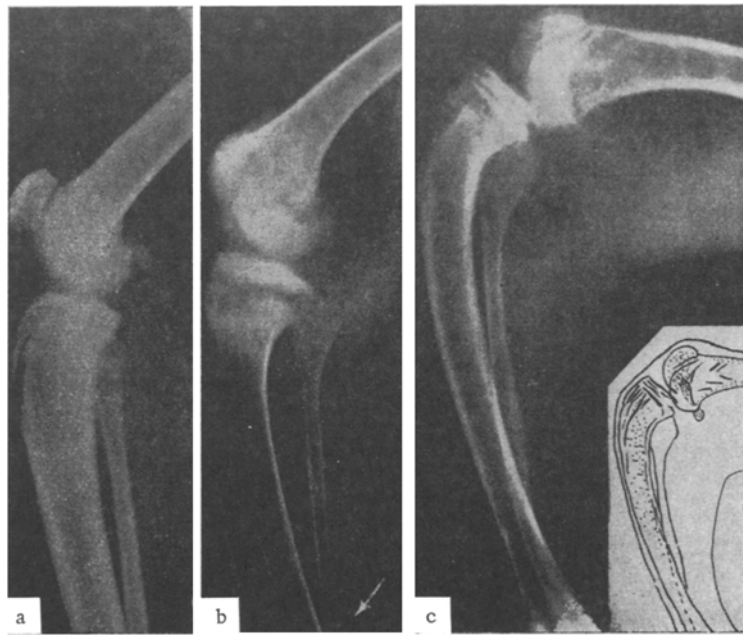


Fig. 2. Roentgenogram of the right knee of the monkey Kastrop — normal for comparison (a). Roentgenogram of right knee and leg of the monkey Antopol' (b): transformation of bone tissue in the region of the metaphyses of the bones — cyst-like zones of rarefaction alternate with areas of condensation, zone of growth of cartilage widened, a Looser's transformation zone is present at the junction between the middle and distal thirds of the fibula, with a sleeve of callus (marked by arrow). Roentgenogram of leg and knee of monkey Gelendzhik with diagrammatic representation (c): hypertrophic osteoporosis and saber-like deformity of proximal third of tibia.

phenomenon was observed 4–5 months after the end of psychic trauma: the gait of one of the monkeys (Antopol') was changed; the distal ends of the forearm bones were thickened and deformed. For this reason, a thorough roentgenologic investigation was made of the skeleton of all experimental animals.

The skeleton of the monkey Antopol' was investigated one year after the beginning of psychic trauma and 6.5 months after its end, while the other three animals were examined after one year, 4 months, and 11 months respectively.

Roentgenologic examination of all the experimental animals revealed marked degenerative changes in their skeleton. The most conspicuous feature was generalized systemic osteoporosis, especially of the spine, followed by (in descending order) the skull, pelvic bones, limbs, and segments of the tail. Roentgenograms of the spine showed a decrease in height of the vertebral bodies, more especially in their anterior portions, leading to wedge-shaped deformity of the vertebrae. In two monkeys (Gelendzhik and Mal'chik) prolapse of nucleus pulposus was observed. Changes were found in the structure of the bone tissue of the vertebrae and their density was reduced. In cases of marked osteoporosis, the vertebrae of the monkeys became "glassy," i.e., they were difficult to differentiate against the soft tissues.

In three animals (Gelendzhik, Mal'chik, and Kolet), bands of translucency extending throughout their diameter and from 1 to 3 mm in width were observed beneath the articular surfaces of the vertebral bodies on both sides. Parallel to these were lines of condensation, making it appear that the outlines of the vertebral bodies on their upper and lower surfaces were double (Fig. 1). These bands of translucency, roentgenologically analogous to Looser's zones of transformation of bone tissue, are interpreted as a special type of transformation of the bone structure. Normal weight-bearing may be excessive for pathologically changed bones, and may lead to appearance of zones of transformation.



Fig. 3. Roentgenogram of skull and cervical spine of the monkey Antopol'. Marked osteoporosis; the mandible is hardly visible against the background of the clearly defined soft tissues.

A true Looser's transformation zone with the formation of a sleeve of callus was observed in the fibulae of two monkeys — Gelendzhik and Antopol' (Fig. 2).

Osteoporosis of the skull in the monkeys was well marked in some cases, and the individual cranial bones (especially the mandible) could hardly be differentiated on the roentgenogram from the soft tissues (Fig. 3).

Degenerative changes were also found in the long bones of these animals. In this case osteoporosis took the form of randomly scattered cyst-like translucencies, differing in size and shape. They were particularly marked in the distal parts of the radius and femur. The medullary canal of the long bones appeared widened, and the cortical layer thin and nonhomogeneous. The bones showed longitudinal striation, and the wall of the medullary canal was no longer sharply defined.

Considerable changes were also found in the hind limbs of the monkeys, especially near the knee joint. Hypertrophic osteoporosis was observed in the proximal end of the tibia. The structure of the articular ends of this region was modified — areas of rarefaction of bone tissue alternated with areas of marked condensation. The bones showed a saber-like deformity. The distal end of the femur formed a continuous curve, concave anteriorly (Fig. 2c). A valgus (X-shaped) deformity of the bones of the hind limbs, with considerable transformation of their structure, was observed in one of the monkeys (Mal'chik).

If degeneration was advanced, osteoporosis could be detected in all bones of the skeleton, including in segments of the tail.

The development of skeletal osteoporosis was therefore demonstrated in all experimental monkeys in this investigation in the postneurotic period. Osteoporosis is now regarded as degeneration of the bones [1, 3-5]. The basis of the degenerative changes in the skeletal system of the monkeys was a functional disturbance of the central nervous system.

Psychic trauma, disturbing the function of the higher levels of the central nervous system and of the corresponding neurodynamic structures, may lead to the development of degenerative change in the monkey's skeleton of the systemic osteoporosis type, with disturbance of the mineral composition of the bones, the development of Looser's transformation zones, and changes in the structure of the bone tissue. Against the background of these changes deformation of the skeleton takes place, especially of those parts of it mainly concerned with weight bearing (the spine and hind limbs).

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