EFFECT OF EXTIRPATION OF THE CERVICAL SYMPATHETIC GANGLIA ON POSTNATAL GROWTH OF RATS

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Bilateral extirpation of the superior cervical sympathetic ganglia during the first months of life in young rats caused retardation in growth by 40-60%. Division of preganglionic sympathetic fibers and mock operations produced no significant changes. Normal growth and development of the skeleton were disturbed in the ganglionectomized rats: the zone of growth of the proximal end of the tibia in the ganglionectomized animals was much narrower than in the intact controls and delay in the spread of secondary centers of ossification was observed.

KEY WORDS: ganglionectomy; growth of animals; development of skeleton.

Bilateral extirpation of the superior cervical sympathetic ganglia (SCSG) in rats aged 5-7 days causes retardation in growth, sparseness of the hair, and delay in the acquisition of sight [14]. A similar picture has been observed [5, 6] after unilateral as well as after bilateral extirpation of SCSG.

The object of this investigation was to study the effect of ganglionectomy over a long period of time and to discover at what age the removal of SCSG has the greatest effect on growth. By histological investigation of skeletal development a closer approach can be made to the understanding of the neurohormonal mechanism of delayed growth in ganglionectomized animals.

EXPERIMENTAL METHOD

Extirpation of SCSG was carried out on the right side or bilaterally under ether anesthesia. Observations on the change in weight until the age of 5-8 months were made on 17 control rats, on 16 rats undergoing right-sided ganglionectomy during the first days of life, and also on 29 control rats and 18 rats undergoing the bilateral operation. A mock operation was performed on six young rats and decentralization of SCSG was carried out on 23 rats of different ages by division of the preganglionic fibers. Observations also were made on rats on which the operation was performed at a later age. Attention was directed toward the nutrition of the intact and ganglionectomized rats. Since sex-linked differences in rates of growth exist [17], it must be emphasized that the information given in this paper was obtained purely on male rats. Statistical analysis of the results was carried out by computer.

EXPERIMENTAL RESULTS

Retardation in growth after unilateral extirpation of SCSG was observed mainly when the operation was performed on the first or second day of life, and after bilateral extirpation during the first month of life. The weight of the rats undergoing the operation was 40-60% less than that of intact rats (Fig. 1). The greatest retardation was observed in the first month of life, when the rate of growth in the intact animals was particularly high [10]. Starting with the second month, the mean gain in weight of the ganglionectomized rats reached the intact level, but the sharp decrease in the rate of growth in the first month of life meant

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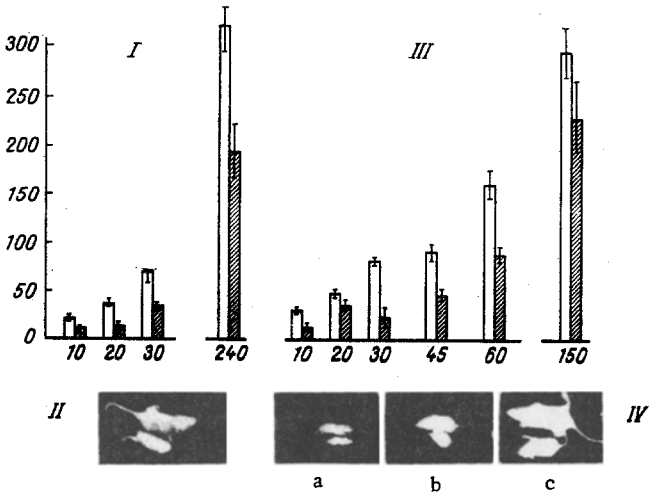

Fig. 1. Effect of extirpation of SCSG, carried out at an early age, on weight and growth of rats in postnatal ontogeny. Unshaded columns – weight of intact rats, shaded columns – weight of ganglionectomized rats. I, II) Effect of right-sided extirpation of SCSG carried during first two days of life on weight and growth respectively of rats (intact rat shown above on photographs, ganglionectomized rat below – at age of 1 month); III, IV) effect of bilateral extirpation of SCSG carried out during first five days of life on weight and growth respectively of rats (top animal in photograph is intact, bottom animal is ganglionectomized rat at age of 11 days (a), 20 days (b), and 2 months (c). Abscissa, age (in days); ordinate, weight (in g).

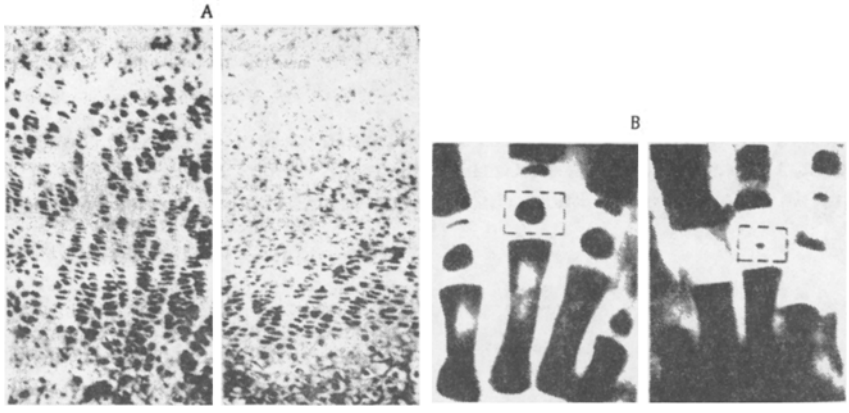

Fig. 2. Effect of extirpation of SCSG on skeletal growth and differentiation in rats. A) Epiphyseal zone of growth of proximal end of tibia in intact (left) rat and rat undergoing bilateral ganglionectomy at age of three days (right) (Heidenhain's azan, 160 ×); B) secondary center of ossification of third metacarpal bone outlined in intact (left) and ganglionectomized (right) rat (alizarin red S; 15 ×). Age of rats 11 days.

that growth of the experimental rats still remained behind the control. Similar results were obtained in Arshavskii's laboratory [3] when young rats were treated with resperine.

Division of the preganglionic fibers of SCSG in the rats or mock operations produced no significant changes in their growth.

The pituitary and thyroid glands, for which SCSG is the source of the sympathetic innervation [8, 9], play an important role in the regulation of growth. Pituitary somatotropic hormone has a specific effect on growth of epiphyseal cartilages, responsible for growth of the bones, whereas thyroxine ensures the necessary level of metabolism for intensive growth, differentiation of the skeleton, normal growth, and differentiation of the pituitary acidophils, which produce somatotropic hormone [2, 4, 7, 18]. In the embryonic period of rats, growth is dependent on the somatotropic function of the pituitary [13]. Histological investigation of the epiphyseal cartilage at the proximal end of the tibia in intact and ganglionectomized rats showed that the epiphyseal zone of growth in the latter was much narrower than normal and the cartilage cells of the disc were smaller (Fig. 2A). As in thryoidectomized animals [11], either delay in the appearance of the secondary center of ossification for the third metacarpal bone or delay in its spread was observed in rats after removal of the SCSG (Fig. 2B). The baldness of the head and trunk along the spine observed in the ganglionectomized rats is another feature reflecting thyroid hypofunction [4]. The results demonstrate the important role of SCSG in the neurohormonal regulation of growth.

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