MYELINIZATION OF THE PREGANGLIONIC FIBERS OF THE CERVICAL SYMPATHETIC TRUNKS IN RABBITS IN POSTNATAL ONTOGENESIS

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Investigations of the superior cervical sympathetic ganglia of rabbits in ontogenesis have shown that during development of these animals changes take place in the character of the background and the evoked bioelectrical activity of the preganglionic fibers and the cells of the ganglia [1-4, 8].

In early periods of postnatal development the duration of these potentials is longer and they have a long latent period of origin, demonstrating the low velocity of conduction of excitation in the preganglionic fibers. At the same time, studies of the neurohumoral regulation of excitation in the synapses of the ganglion have shown that in newborn animals the transmission of impulses is adrenergic, whereas in adult animals it is cholinergic [5-7].

These findings led to the examination of the structure of the preganglionic fibers at various stages of postnatal ontogenesis. The results of the study of the structure of these fibers showed that in newborn animals they are nonmedullated but in adult animals they are mainly medullated [5, 7]. No other facts concerning the myelinization of the cervical sympathetic structures during ontogenesis could be found in the literature.

The object of the present investigation was to examine the degree and the times of myelinization of the fibers of the cervical sympathetic trunk in rabbits during postnatal ontogenesis.

EXPERIMENTAL METHOD

Experiments were carried out on 35 preganglionic cervical sympathetic trunks of rabbits of different ages. The trunks were taken along their whole length from the stellate ganglion to the superior cervical sympathetic ganglion, fixed in formalin and embedded in celloidin. Transverse sections were made through the cranial portions of the trunks situated near the superior cervical sympathetic ganglion, and the middle and caudal portions. The thickness of the sections was 20 μ. They were stained by the Weigert–Pal method in Kulchitsky's modification.

The degree of myelinization was estimated from the number of medullated fibers in the cross section of the trunk, from the diameter of the medullated fibers and from the thickness of the layer of myelin. The medullated fibers were counted throughout the area of cross section, and their diameter was measured together with that of the myelin sheath by means of an ocular micrometer.

The animals were subdivided into six age groups. Group 1 included newborn rabbits and rabbits during the first days of life, group 2–rabbits aged 6-7 days, group 3–aged 10-12 days, group 4–aged 21-25 days, group 5–rabbits aged 1 month, and group 6–rabbits aged from 3 months to 1.5 years.

EXPERIMENTAL RESULTS

In the newborn rabbits the preganglionic fibers of the cervical sympathetic trunk were mainly nonmedullated (Fig. 1, a). Myelinization of the preganglionic fibers of the cervical sympathetic trunk began during the first days after birth. On the 3rd-4th day of life small groups of well defined medullated fibers could be observed constantly in the cervical sympathetic trunks. By the 6th-7th day the number of meculated fibers in the cervical sympathetic trunk had increased considerably. They were more numerous still when the animals acquired vision, i.e., on the 10th-12th day (Fig. 2, b). During the second half of the first

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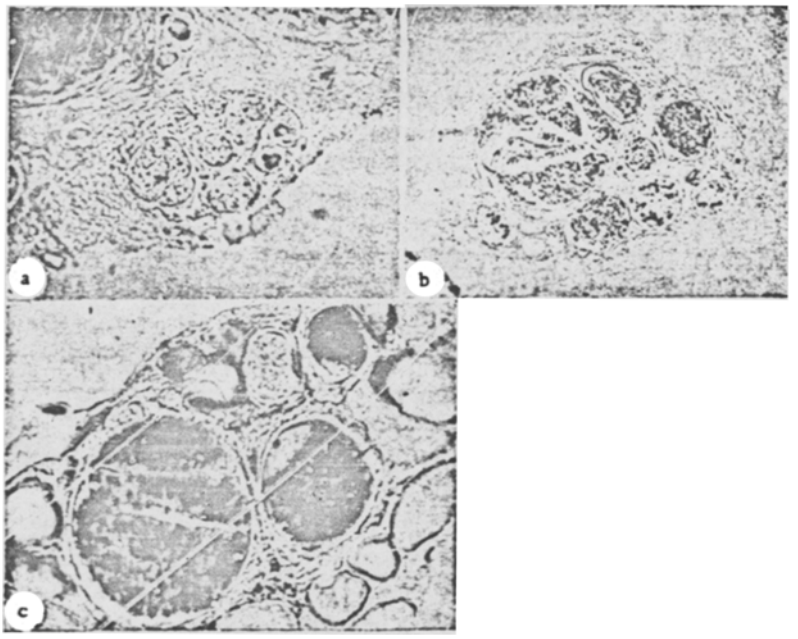

Fig. 1. Transverse sections of cervical sympathetic trunks of a newborn rabbit (a), and of rabbits aged 1 month (b) and 3 months (c). Photomicrograph. Kulchitsky's modification of the Weigert–Pal method. Objective 40×, ocular 10× (a); objective 40×, ocular 5× (b and c).

month of life the number of medullated fibers along the course of the trunk increased most intensively, and by the end of the first month their number reached 1000 fibers per section (Fig. 1, b).

The process of myelinization of the fibers in the preganglionic trunk was not uniformly expressed along the whole course of the cervical sympathetic trunk, especially in the early stages, but initially was most marked in its caudal portion. Preganglionic medullated fibers first appeared in the caudal portions of the trunk in rabbits during the first 3 days of life. By the age of 6-7 days the number of medullated fibers in the caudal portions of the trunk increased considerably, whereas in the cranial portions of the trunk no medullated fibers could yet be seen. Not until the 10th-12th day was myelinization of some fibers observed in the cranial portion of the trunk. By this time the number of medullated fibers in the caudal portion had reached 360 per section compared with 80 in the cranial portion (Fig. 2, a and b). By the end of the first month of life these differences in numbers had largely disappeared.

The period of appearance of well marked medullated fibers was preceded by a period of latent myelinization before the medullated fibers could be distinguished by the Weigert–Pal method but when they were colored various shades of brown appeared–from very pale to dark. Fibers stained brown could be seen in the transverse section of the cranial portions of the cervical sympathetic trunks even on the first day after birth. Careful study revealed very thin, dark rims around the edge of the stained fibers, apparently the outlines of the future myelin sheath. These rims disappeared during decolorization of the same fibers in the course of subsequent differentiation. In the later stages the initial "rims" were converted into myelin sheaths. Hence, in the early stages of myelinization, the gradual decolorization of the brown fibers could be seen especially clearly with different degrees of differentiation, leaving behind only the pale outlines of the myelin sheath.

According to data in the literature [9-11], the lipids composing the myelin sheaths appear in the central nervous system in a definite order: first the gangliosides, then sphyngomyelin, and last the cerebrosides, associated with staining properties by the Weigert–Pal method. The content of cerebrosides increases parallel with the process of myelinization, while cholesterol and phospholipids can be found even before this process begins. That is possibly why during myelinization of the preganglionic fibers of the cervical sympathetic trunk a successive incorporation of the different lipids takes place, as reflected by the degree of staining of the fibers by the Weigert–Pal method.

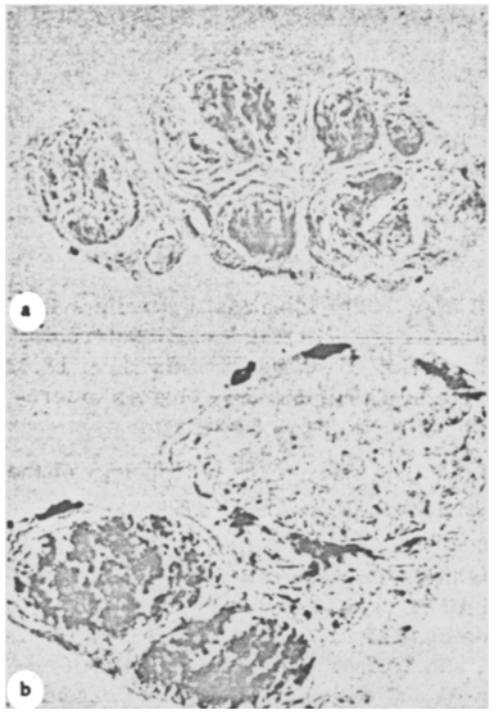

Fig. 2. Transverse sections of the cervical sympathetic trunk of a rabbit aged 10 days. a) Section through cranial portion of trunk; b) section through caudal portion of trunk. Photomicrograph. Kulchitsky's modification of the Weigert–Pal method. Objective 40×, ocular 10×.

It is also interesting to note that in the early stages of myelinization, fibers with a well defined myelin sheath were not uniformly distributed throughout the bundles in the caudal portions of the trunks, but were concentrated in one or two bundles. This took place mainly during the first 12 days after birth. Later, starting with the second half of the first month of life, myelinization affected the fibers more uniformly throughout the bundles composing the trunks. In the proximal portions of the trunks, starting from the beginning of myelinization, medullated fibers were found scattered among the different bundles.

The results of the investigation of the structure of the preganglionic fibers in the cervial sympathetic trunks of rabbits aged between 3 months and 1.5 years showed that most of the preganglionic fibers were medullated (Fig. 1, c). The number of medullated fibers varied along the course of the trunk on the average from 1500 to 2000 per section. Most of the medullated fibers of the adult rabbit were 2-3 μ in diameter; many fibers were found with a diameter less than 2 μ. Comparison of the diameters of the medullated fibers at the different age periods showed that from the time of appearance of these fibers until the time of their final maturation in the adult state the total diameter (together with the myelin sheath) varied by 3 μ. The thickness and intensity of staining of the myelin sheaths varied during postnatal ontogenesis from very thin rims distinguishable under the immersion lens, to brightly stained, jet-black rings.

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