All that can be suggested as yet is that these conditions are connected with the presence of the hypothetical factor, mentioned above, inhibiting migration of the cells producing amyloid (amyloidoblasts), a factor which not only acts at the intercellular level, but is also secreted in the blood stream. When the migration activity of the cells was estimated by the method of Soborg and Bendixen [7], the results obtained indicated that the ability of spleen cells to migrate falls progressively in the course of the induction of amyloidosis.

From the standpoint of the phenomenon just described above, the following clinical observation is interesting. Two patients with amyloidosis of the kidneys, developing as a complication of osteomyelitis and periodic disease, were treated by transplantation of a kidney because of the onset of chronic renal failure. Morphological investigation 2 years after the operation showed no amyloid deposits in the graft, despite amyloidosis of the other organs [1]. The authors who described this case consider that it may be due to the intensive immunodepressive treatment given to these patients. However, this seems unlikely in view of the many experimental and clinical observations indicating that amyloid production is stimulated by immunodepressants. The absence of deposits of amyloid in an intact spleen grafted into recipients with marked systemic amyloidosis is evidently an experimental model of the case just described.

LITERATURE CITED

1. V. V. Sura, V. V. Serov, M. P. Chebyshev, et al., Byull. Éksp. Biol. Med., No. 12, 95 (1974).
2. F. Hardt et al., Clin. Exp. Immunol., 10, 487 (1972).
3. F. Hardt and P. Ranlov, Acta Pathol. Microbiol. Scand., 73, 549 (1968).
4. F. Hardt, Acta Pathol. Microbiol. Scand., 79A, 61 (1971).
5. D. T. Janingan and R. L. Druet, Am. J. Pathol., 52, 381 (1968).
6. P. Ranlov and O. Werdelin, Acta Pathol. Microbiol. Scand., 70, 249 (1967).
7. M. Soborg and G. Bendixen, Acta Med. Scand., 181, 247 (1967).
8. O. Werdelin and P. Ranlov, Acta Pathol. Microbiol. Scand., 72, 13 (1968).

MORPHOLOGY AND FUNCTION OF THE DUODENAL CHOLINERGIC NERVOUS SYSTEM UNDER NORMAL CONDITIONS AND AFTER SUBDIAPHRAGMATIC VAGOTOMY

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A histochemical investigation was made of the intramural nervous system of the albino rat duodenum under normal conditions and after bilateral subdiaphragmatic vagotomy. Morphometric and microspectrofluorometric observations showed a decrease in the number of detectable nerve fibers and in acetylcholinesterase (AChE) activity in them after a transient rise in these indices on the first day after vagotomy, followed by a return to their original levels.

KEY WORDS: cholinergic nerve fibers; acetylcholinesterase; subdiaphragmatic vagotomy.

Histochemical investigations have shown reasonably clearly that adrenergic and cholinergic components of the nervous system participate in duodenal innervation [1, 4, 15]. The structural organization of the intramural ganglia of the duodenum has also been shown to be heterogeneous: neurons of qualitatively different nature have been found in their composition [1, 4, 12]. However, there is still very little information on the response of nerve cells of the intramural ganglia when isolated from the CNS. Yet the solution to this problem is important, for knowledge of the principles governing the morphological reorganization of the duodenal nervous system under these conditions is essential to the understanding of the development of the morphological changes in the tissues of the organ after denervation.

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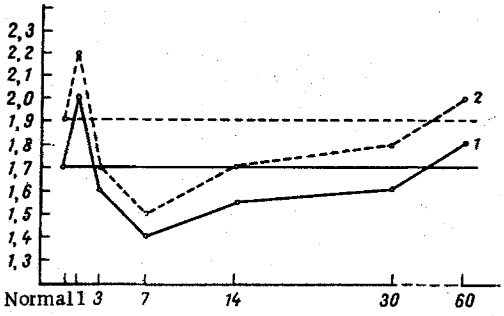

Fig. 1

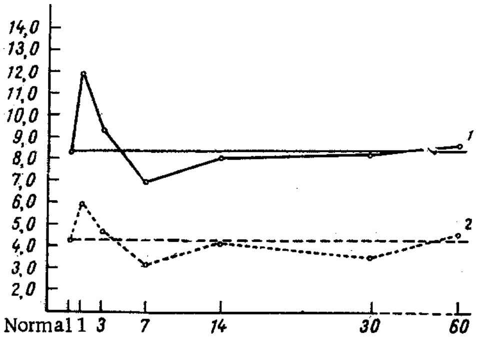

Fig. 2

Fig. 1. Changes in AChE activity in duodenal nerves at different times after vagotomy. Abscissa, time after operation (in days); ordinate, AChE activity (in relative units). Here and in Figs. 2 and 3: 1) muscular layer, 2) submucous layer of duodenum.

Fig. 2. Changes in number of detectable ChNF in duodenum at different times after vagotomy. Abscissa, time after operation (in days); ordinate, number of ChNF (in relative units).

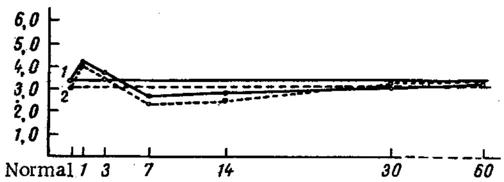

Fig. 3. Changes in mean areas of detectable cholinergic nerve fibers of duodenum at different times after operation. Abscissa, time after operation (in days); ordinate, mean areas of cholinergic nerve fibers (in relative units).

The object of this investigation was to compare the structural organization of the intramural nervous system of the duodenum under normal conditions and after bilateral subdiaphragmatic vagotomy.

EXPERIMENTAL METHOD

Experiments were carried out on noninbred male rats weighing 150-200 g. Under ether anesthesia bilateral subdiaphragmatic vagotomy was performed on the experimental animals. The rats were decapitated 1, 3, 7, 14, 30, and 60 days after the operation. Material was taken from six vagotomized and six control animals at each time. Altogether 72 rats were used. Sections 10-15μ thick were cut on a cryostat from combined (experimental and control) blocks. Cholinergic nerve fibers (ChNF) were demonstrated by Karnovsky's thiocholine method. Acetylcholinesterase (AChE) activity in the nerve fibers of the submucous and muscular layers was determined on a microspectrofluorometer, with processing of the data on the "Mir-2" computer. A morphometric investigation of the number of detectable nerve fibers per unit area and also of their mean areas was carried out on the same sections by a grid method, using an ocular attachment to the microscope suggested [8] for morphometric measurements. The error and confidence intervals of the arithmetic means were determined from tables [9]. The results of the measurements were represented graphically.

EXPERIMENTAL RESULTS

Many ChNF were found in the submucosa, in the circular and longitudinal layers of the muscular wall of the duodenum. At the base of the villi and in the adventitia of the blood vessels they formed a dense network. The nerve fibers had irregular outlines and very often thickenings resembling varicose formations were discovered along their course. Singly or in the composition of large trunks the ChNF penetrated into the intramural ganglia of the submucous and intermuscular nervous plexuses. In this situation they were diffusely arranged and formed synaptic contacts with neurons of the ganglia or, by-passing them, ran toward the structures of the organ which they innervated. In the neurons of the intramural ganglia AChE activity varied. The results of the morphometric and microspectrofluorometric measurements are given in Figs. 1-3 and they show that the mean areas of the ChNF in the intermuscular and submucous plexuses were identical (3.4 ± 0.2 and 3.1 ± 0.4 respectively), whereas their number per unit area was twice as great in the intermuscular layer as in the submucous layer (8.4 ± 0.5 and 4.3 ± 0.8 respectively). AChE activity was rather higher in the fibers of the submucous layer. These results, like those of other investigators [1, 6, 12, 15], indicate that the intermuscular plexus is more highly developed and responsible for the innervation of the structural components of the mucous and muscular membranes [6], whereas the ganglia of the submucous layer innervate only the muscle tissue of the mucosa and the structures of their own layer. It can tentatively be suggested that the low density of nerve fibers detected in the submucous layer compared with the intermuscular layer is compensated by the higher level of their AChE activity.

Analysis of the indices of AChE activity in the nerve fibers of the submucous and intermuscular plexuses (Fig. 1) at different times after subdiaphragmatic vagotomy showed that in the beginning (the first day after the operation) the enzyme activity increased, but by the third and, in particular, the seventh day after the operation it showed an appreciable fall. Subsequently it returned gradually to its initial level. Comparative morphometric investigation of the number of nerve fibers per unit area and of the mean areas of the fibers themselves revealed a definite pattern of change of these indices at different times after the operation (Figs. 2 and 3). As Fig. 2 shows, the number of nerve fibers detected on the 1st day after the operation increased fairly sharply (from 8.4 ± 0.5 and 12.0 ± 1.2 in the intermuscular plexus and from 4.3 ± 0.8 to 6.0 ± 0.3 in the submucous plexus), and then fell gradually, to reach a minimum by the seventh day (from 8.4 ± 0.5 to 7.0 ± 0.4 in the intermuscular and from 4.3 ± 0.8 to 3.2 ± 0.2 in the submucous plexus). Starting from the 14th day a gradual return to the original level was observed. Similar changes were found when the mean areas of detectable ChNF were measured in the intermural plexuses (Fig. 3).

It can thus be concluded from these results that subdiaphragmatic vagotomy causes definite changes in the state of the intramural nervous system. These changes are expressed as changes in the number of detectable nerve fibers and in the degree of AChE activity in them. Comparison of the morphometric data with the results of microspectrofluorometric analysis showed correlation between the number of nerve fibers detected and the level of AChE activity in them (on the first and on the seventh day), namely a decrease in the level of these indices during the first week after an initial temporary increase on the first day after the operation. The results described above agree with those of the writers' previous investigations of the state of the duodenal nervous system after vagotomy [2, 3] and with the results of biochemical investigations of the acetylcholine concentration and of acetylcholinesterase activity in organs with disturbed innervation published in the literature [13, 14]. Comparison of the results of the present investigation with data in the literature suggests that high enzyme activity and, consequently, an increase in the number of detectable nerve fibers, on the first day after the operation was a response of the duodenal nervous system to an increased content of mediator. The sharp decrease in AChE activity in the neurons of the intramural nervous system on the seventh day after the operation must be regarded as a morphological expression of degenerative changes developing in them as a result of the degeneration of the preganglionic nerve fibers taking place after the 1st day. The return of all the parameters toward their control levels on the 30th-60th day after the operation confirms the hypothesis that compensatory and adaptive processes develop in structures of the intramural nervous apparatus of the internal organs which remain viable after disturbance of their connection with the CNS [5, 10, 11]. It seems probable that the fundamental role in the restoration of the normal morphology and function of the nervous system is played by intracellular regeneration of the neurons. At the same time there is reason to suppose that the development and increasing complexity of the intercellular connections, not only because of processes of the neurons located in the wall of the duodenum, but also on account of preganglionic nerve fibers which converge on the intramural ganglia of the duodenum, not from the trunk of the vagus nerve but from other sources [7] and in the composition of other nerves, also play a definite role.

It can thus be concluded from the results that disturbance of the connection of the intramural nervous system of the duodenum with the CNS leads to changes of a reversible character in that system. Two phases can be distinguished in the dynamics of the processes as they develop: destructive, during the first week after disturbance of connections with the CNS, and reparative, with effect from the second week after the operation.

LITERATURE CITED

1. A. P. Ambros'ev, Adrenergic and Cholinergic Innervation of Organs of the Digestive System [in Russian], Minsk (1977), p. 111.
2. Yu. K. Eletskii and M. I. Shashirina, Byull. Éksp. Biol. Med., No. 4, 492 (1976).

3. Yu. K. Eletskii, O. M. Zorina, and M. I. Shashirina, Arkh. Anat., No. 7, 32 (1977).
4. E. M. Krokhina and L. M. Chuvil'skaya, Byull. Éksp. Biol. Med., No. 3, 110 (1975).
5. V. Sh. Malatsidze, Byull. Éksp. Biol. Med., No. 11, 116 (1975).
6. E. P. Mel'man, The Functional Morphology of Innervation of the Digestive Organs [in Russian], Moscow (1970), pp. 121-133.
7. V. Kh. Mitroshenko, Khirurgiya, No. 3, 50 (1956).
8. S. B. Stefanov, Tsitologiya, No. 11, 1430 (1974).
9. R. B. Strelkov, Method of Calculation of the Standard Error and Confidence Intervals of Arithmetic Means by Means of a Table [in Russian], Sukhumi (1966).
10. M. Z. Chunaeva, "Histophysiology of the intramural apparatus during inhibition or stimulation of the sympathetic division of the autonomic nervous system," Author's Abstract of Candidate's Dissertation, Moscow (1973).
11. N. E. Yarygin and V. N. Yarygin, Pathological and Adaptive Changes in the Neuron [in Russian], Moscow (1973), pp. 108-117.
12. G. Gobella, Z. Zellforsch., 125, 191 (1972).
13. P. F. Munari, G. P. Cordioli, and R. Bernardi, Boll. Soc. Ital. Biol. Sper., 48, 701 (1972).
14. G. Pilar, D. J. Jenden, and B. Campbell, Brain Res., 49, 245 (1973).
15. M. Schardt and E. van der Lypen, Acta Anat. (Basel), 90, 403 (1974).

ULTRASTRUCTURE OF THE ADRENAL MEDULLA AND BLOOD CATECHOLAMINE LEVEL DURING BURN TRAUMA

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The results of an electron-microscopic analysis of the adrenal medulla were compared with those of biochemical investigation of the blood catecholamine level during burn shock. In the erectile phase of burn shock adrenalin and noradrenalin stored in the depots is released, whereas in the torpid phase further liberation of the contents of the granules is accounted for entirely by adrenalin. A distinguishing feature of this period is the intensification of synthesis. After burning a holocrine type of secretion predominates and leads subsequently to exhaustion of the adrenal medulla. Reparative processes are characteristic of burns, but the synthesis and secretion of catecholamines take place less intensively than in healthy animals.

KEY WORDS: burn trauma; sympathico-adrenal system; catecholamines; secretory granules.

There is no question of the urgent importance of the study of the role of the sympathico-adrenal system (SAS) in the response to burns. However, the available information does not give a complete picture of the functional state of the adrenal medulla [2, 4, 7, 15]. There have been few light-optical investigations of the adrenal medulla during burn trauma [3, 8] and no information on ultrastructural changes in the medulla is to be found in the literature.

The object of this investigation was to make an electron-microscopic analysis of the adrenal medulla and to compare the results with those of biochemical determination of the blood catecholamine level in the course of burn shock.

EXPERIMENTAL METHOD

Burn shock was produced in experiments on 30 dogs by the method described earlier [1]. The blood pressure was recorded by a mercury manometer in the common carotid artery.

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