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CHANGES IN G-, ECL- AND EC-CELLS IN THE GASTRIC AND DUODENAL MUCOSA AFTER EXPERIMENTAL SELECTIVE PROXIMAL VAGOTOMY

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UDC 616.342-002.44-089:616.833.191-089.85-089.168-07:[616.33+616.342[-018.73-091.8

KEY WORDS: endocrine cells; apudocytes; vagotomy; histochemistry; electron microscopy.

Selective proximal vagotomy (SPV), an organ-sparing operation, is widely used in the treatment of diseases of the duodenum and stomach. Its therapeutic effect is connected with abolition of the stimulating influence of the vagus (acetylcholine) on the parietal cells. However, various complications may arise after vagotomy, due to changes in the mechanisms of neurogenic and hormonal regulation of gastric secretion and, in particular, to interaction between the vagus and G-, ECL-, and EC-cells. Information about changes in the G-, ECL-, and EC-cells in the stomach and duodenum after SPC is limited [2-4]. The effect of vagotomy on G-, ECL-, and EC-cells simultaneously has virtually not been studied. In order to examine these problems, the effect of SPV on G-, ECL-, and EC-cells, synthesizing the chief stimulators (gastrin and histamine) and modulators (serotonin) of the gastric secretion, was studied experimentally.

EXPERIMENTAL METHOD

Experiments were carried out on 120 albino rats divided into two groups (60 rats in each group, 10 rats in each series): group 1 (control) rats undergoing laparotomy only; group 2) rats undergoing SPV. The rats were decapitated under superficial pentobarbital anesthesia 24 h, 3, 7, and 15 days, and 1 and 6 months after the operation. Sections of the stomach and duodenum were stained with hematoxylin and eosin, by Grimelius's reaction (for argyrophilic cells), by the Masson–Fontana reaction (for argentaffin cells), and by Sevki's reaction (to detect ECL-cells, which stain blue-violet on account of the presence of histamine). The number of endocrine cells was counted by means of Avtandilov's grid in 1 mm^2 of mucosa under a magnification of 400. The results were subjected to statistical analysis by Student's test. Pieces of tissue for electron-microscopic study were fixed in solutions of glutaraldehyde and osmium tetroxide and then embedded in Epon-812.

Department of Operative Surgery and Topographic Anatomy, N. Marimanov Azerbaijan Medical Institute, Baku. (Presented by Academician of the Academy of Medical Sciences of the USSR D. S. Sarkisov.) Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 106, No. 8, pp. 238-240, August, 1988. Original article submitted June 19, 1987.

 0007-4888/88.0008-1192$12.50

TABLE 1. Number of G-, ECL-, and EC-Cells in Gastric and Duodenal Mucosa after Selective Proximal Vagotomy (per 1 mm², magnification 400×)

Time after vagotomy	Stomach							
	antral region			body		crypts		
	G	ECL	EC	G	ECL	EC	G	ECL
24 h	216,5±1,52	67,1±0,99	42,1±0,8	10,3±0,19	128,8±1,69	31,7±0,91	8,2±0,1	23,1±0,79
72 h	196,1±1,35	58,8±1,44	21,5±0,75	9,1±0,19	114,3±1,48	16,2±0,79	7,5±0,11	18,3±0,58
7 days	123,6±0,83	51,3±1,19	52,2±1,4	5,2±0,12	108,0±2,16	39,8±0,73	7,0±0,12	14,7±0,91
15 days	238,2±1,12	72,3±2,36	31,4±1,06	12,1±0,47	149,5±2,4	22,5±0,8	8,9±0,13	27,5±0,82
30 days	115,3±1,38	49,5±1,03	28,6±1,4	7,8±0,13	102,1±1,84	19,3±0.79	5,9±0,09	16,1±0,79
6 months	139,9±1,45	41,1±0,75	30,7±1,15	8,0±0.2	92,21±1,62	20,1±0,9	6,1±0,08	10,1±0,59
Control	143,4±1,93	43,4±0,92	29,2±0,7	7,4±0,1	92,5±1,2	21,3±0,8	6,2±0,1	9,1±0,09

Time after vagotomy	Duodenum						
	villi				total		
	EC	G	ECL	EC	G	ECL	EC
24 h	77,6±1,63	7,3±0,12	9,4±0,33	43,2±0,75	15,5±0,22	32,5±1,9	120,8±2,38
72 h	51,8±1,1	7,1±10,12	7,8±0,37	27,2±0,79	14,6±0,23	26,1±0,95	79,0±1,89
7 days	85,3±1,58	6,1±0,09	7,1±0,39	51,4±1,47	13,1±0,21	21,9±1,4	136,7±2,95
15 days	65,4±1,12	7,38±0,12	12,3±0.65	37,1±0,99	16,3±0,25	39,8±1,4	102,5±2,11
30 days	61,1±1,8	5,78±0,08	7,2±0,36	34,3±1,18	11,7±0,17	23,3±1,15	95,4±2,98
6 months	64,2±2,02	6,9±0,14	7,0±0,43	36,7±1,66	13,1±0,22	17,1±0,91	100,9±3,68
Control	63,7±1,5	6,5±0,08	6,8±0,1	35,8±1,03	12,7±0,18	15,9±0,19	99,5±2,53

EXPERIMENTAL RESULTS

The pathological changes studied belong to the class which have been called "secondary apudopathies" [5]*, for they are reactions, in particular, to vagotomy. This reaction was found to differ at different periods after SPV and for different types of apudocytes studied.

The first stage of disturbances of the apudocytes studied (G-, ECL-, and EC-cells) developed 24 h after SPV. The number (Table 1) and functional activity of all these cells were increased. There is reason to regard this stage as a response to a state of acute stress arising as a result of division of branches of the vagus nerve, termination of the stimulating effect of acetylcholine on parietal and chief cells. The increase in the number of apudocytes was accompanied, as was shown electron-microscopically, by intensification of their functional activity and a consequent rise of their threshold of detectability by the histochemical reaction. Most parietal and chief cells had a normal ultrastructure.

The second stage extends to changes in the apudocytes 7 and 15 days after the operation, depending on the type of endocrine cells: their number was gradually reduced, although not to normal levels, and their functional activity was depressed. In this stage changes took place in the state of the parietal and chief cells: the ultrastructure of their principal organoids and, consequently, their functional activity, were disturbed.

The third stage of disturbances affecting G-, ECL-, and EC-cells was manifested as a new increase in their number, which not only exceeded normal values, but also the number of apudocytes during the first (stress) stage after 24 h. An increase in the number of G- and ECL-cells was observed on the 15th day after vagotomy. The electron-microscopic investigation revealed the cause of this increase, which was connected with a decrease in the number of actively functioning parietal and chief cells, leading to increased functional activity, and, correspondingly, increased detectability of G- and ECL-cells, and intensified synthesis of gastrin and histamine, required for increased stimulation of parietal and chief cells, which remain normal but in reduced numbers, and/or stimulation of the functionally weakened fraction of these cells. Increased functional activity of mucus-forming cells both in the stomach and in the duodenum was found electron-microscopically, confirming the view that the increase in the number of EC-cells at this stage is adaptive in character.

The fourth stage developed later (15 days after vagotomy for EC-cells and 30 days or more after vagotomy for G- and ECL-cells). The number of apudocytes gradually decreased, and their ultrastructure and functional activity returned to normal. By the 6th month, although single apudocytes with ultrastructural disturbances (vacuolation, swelling of the mitochondria, changes in the character of the endocrine granules, etc.), and also parietal and chief cells of dystrophic character, were still found the general picture corresponding to the nor-

*Omitted from the original Russian Bibliography – Publisher.

mal state of cells of the gastric and duodenal mucosa. Consequently, in the late stages the function of the apudocytes studied was normalized at a level adequate to compensate for the loss of the stimulating effect of acetylcholine due to vagotomy.

Evidently in cases when function of the endocrine cells was disturbed, and they were to some degree or other incapable of participating, together with other factors, in compensation of the changes after vagotomy, the conditions are created for postvagotomy complications of different kinds (dumping syndrome, diarrhea, gastro- and duodenostasis, disturbances of function of esophagogastric and gastroduodenal passage, of gastric and intestinal movement, atony, acid formation, etc.).

The histochemical and electron-microscopic investigations thus revealed a series of successive stages in changes in gastric and duodenal G-, ECL-, and EC-cells in response to selective proximal vagotomy, and shed light on the mechanisms of the corresponding changes at the different stages. The general principles of response of the apudocytes of the gastrointestinal tract to SPV, revealed by the investigation, allow a differential pathogenetic approach to be made for influence to be brought to bear in a specific direction on G-, ECL-, and EC-cells, and they enable the most physiological conditions to be created for the normal course of postvagotomy states, and should complications arise after vagotomy, they can indicate optimal methods of treatment by activation of the hormonal factor in combination with therapeutic measures stimulating or inhibiting it.

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CLOSED CHEST METHOD OF INTRAVITAL STUDY OF THE PULMONARY MICROCIRCULATION IN CATS

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UDC 616.16-031:611.24]-092.9-07

KEY WORDS: lungs; microcirculation; capillaries; alveoli; biomicroscopy.

New data indicating significant disturbances of the microcirculatory compartment of the systemic and pulmonary circulations in lung diseases have recently been published [1, 2, 6]. The functional principles of the capillary circulation of the lungs have hitherto been insufficiently studied. This is largely because of technical difficulties arising during intravital study of the microcirculatory bed of the lungs [4]. The most informative of the methods used to study the pulmonary microcirculation is biomicroscopy [3-5].

The aim of this investigation was to modify existing methods of biomicroscopy of the lungs [4, 7] in order to study the pulmonary microcirculation in closed-chest cats breathing naturally. The following problems were solved in the course of the investigation: creation of an apparatus for studying the pulmonary microcirculation the closed chest, choice of optimal conditions of observation and photographic recording of the capillary system of the lungs.

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 0007-4888/88/0008-1194$12.50