A-LIKE CELLS OF THE GASTRIC MUCOSA AS A PROBABLE SOURCE OF PROSTAGLANDINS

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According to data in the literature, stimulation of the vagus nerve leads to prostaglandin secretion from the gastric mucosa [14]. It has also been shown that during stimulation of the vagus a factor inhibiting gastric secretion is released from the gastric mucosa [13]. It is also well known that certain prostaglandins (PGE, PGA) inhibit the secretion of gastric juice, of hydrochloric acid, and of pepsin [2], and that prostaglandin antagonists (acetylsalicylic acid, indomethacin, etc.) intensify gastric secretion and have an ulcerogenic action [4]. Meanwhile it is an interesting fact that tumors arising from endocrine cells of the gastrointestinal tract (carcinoids) very often secrete prostaglandin-like substances [8, 12]. No methods of morphological detection of prostaglandins in the tissues are yet available. Accordingly, it is possible to judge which cells form prostaglandins, derivatives of unsaturated fatty acids only on the basis of indirect data: the presence of lipid inclusions in the cytoplasm, development of a smooth endoplasmic reticulum and Golgi complex, and an abundance of lysosomes, i.e., of organelles maintaining the lipolytic activity of cells. All these organelles are well developed in the AL cells of the acid-producing zone of the rat stomach (Fig. 1). These cells, which resemble only partially, in their histochemical properties, the pancreatic A-cells, have been found in the gastric mucosa [7]. They have been called x-cells, and their close spatial relations with the parietal cells have already been noted. Most investigators are inclined to include AL-cells in the APUD-system. Meanwhile some of their cytochemical properties [9-11] suggest that these cells are characterized by metabolic properties that differ from those of other endocrine cells of the stomach, belonging to the APUD system.

The aim of this investigation was to determine the time course of metabolic disturbances caused in AL cells by stimulation of the vagus nerve, by studying the dynamics of the morphometric parameters of certain organelles.

EXPERIMENTAL METHOD

The vagus nerve was mobilized in the neck on the right side in 12 albino rats under ether anesthesia. A "Cortivar" neuroelectrostimulator was used for stimulation (5 V, 4 msec, 30 Hz, for 10 sec). The animals were decapitated 1, 10, and 30 min after stimulation (three rats at each time). Electrical stimulation was not carried out on three animals of the control group. Material for investigation was taken from the acid-producing zone of the stomach, which was fixed in 4% paraformaldehyde solution, then in 1% OsO_4 solution in Hanks' buffer, then dehydrated and embedded in Epon and Araldite. Ultrathin sections were examined in the JEM-7A electron miscroscope. The volume of the nucleus, cytoplasm, nucleolus, mitochondria, lysosomes, vacuoles, Golgi complex, lipid inclusions, and secretory granules was calculated by stereomorphometric methods [1] and the number of granules also was counted. By a specially developed method the coefficient of crowding of the granules, namely the ratio of the number of control zones in the cross-section of the cytoplasm (CZC) with a high concentration of granules to the number of CZC with a low concentration of granules, was calculated.

EXPERIMENTAL RESULTS

Stimulation of vagus led to marked activation of lipolysis in the AL-cells of the stomach, as shown by corresponding changes in the volumes of the intracellular organelles (Table 1).

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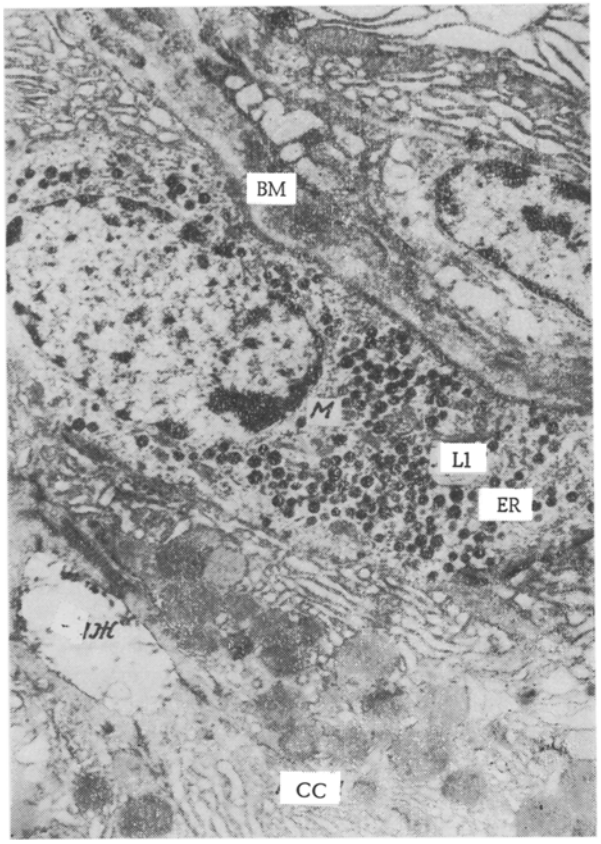

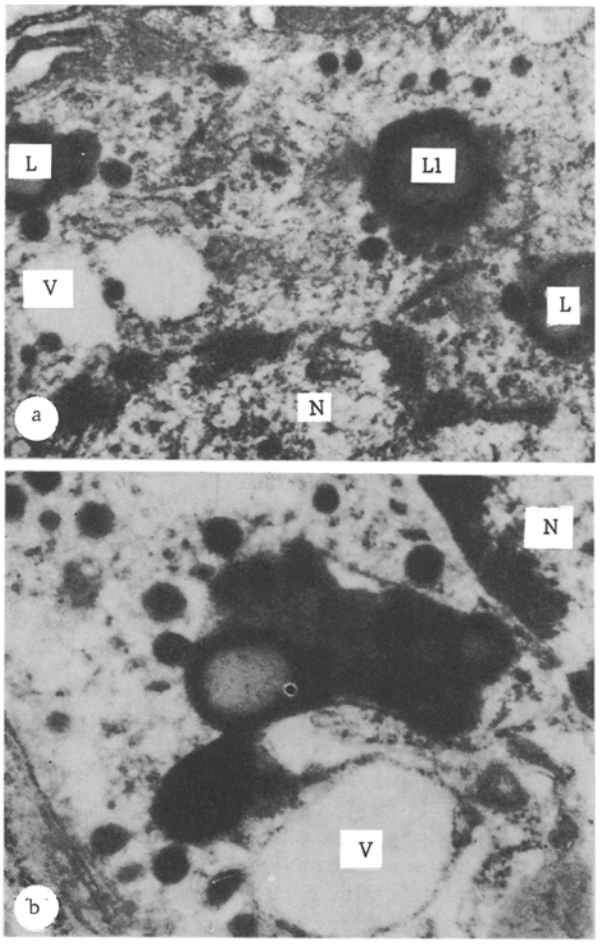

Fig. 1.

Fig. 2

Fig. 1. AL- cells of acid-producing zone of the stomach. BM) Basement membrane, CC) pepsin-producing (chief) cells; LG) lumen of gland; ER) endoplasmic reticulum; M) mitochondria; LI) lipid inclusion. 9000×.

Fig. 2. Activation of lysosomes in cytoplasm of AL-cells of acid-producing zone of stomach after electrical stimulation of vagus nerve: a) many lysosomes (L) in cytoplasm of an AL-cell (25,000 ×); b) "autophagy of secretory granules" in AL-cell. 30,000 ×. N) Nucleus, V) vacuoles. 25,000 ×.

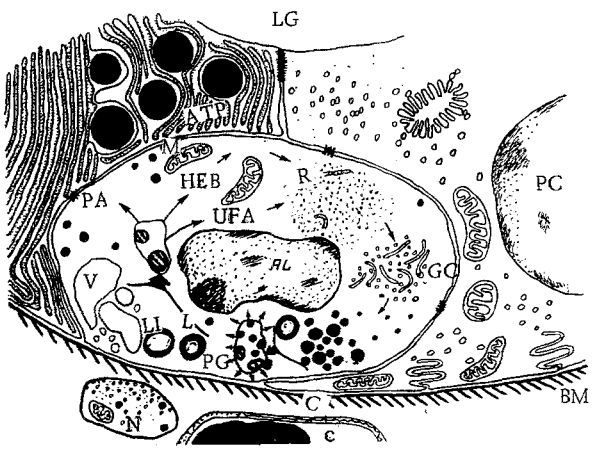

Fig. 3. Scheme of secretory cycle of AL-cells. C) Capillary, V) vacuoles, N) nerve ending, M) mitochondria, R) free ribosomes and polysomes, GC) Golgi complex, SG) secretory granules, PG) prostaglandins, LG) lumen of gland, CC) chief cell, PC) parietal cell, BM) basement membrane, LI) lipid inclusions, L) lysosomes, UFA) unsaturated fatty acids, PA) polyhydric alcohols, HEB) high energy bonds.

TABLE 1. Changes in Morphometric Parameters of AL Cells after Electrical Stimulation of Vagus Nerve

Morphometric parameter		Control	Time after stimulation, min		
			1	10	30
Volume of cell	μ^3	80,6±2,9	137,4±6,7*	133,4±6,0	193,5±8,7*
Volume of nucleus	μ^3	31,0±1,5	38,2±1,9*	38,8±1,9	51,4±2,5*
Volume of nucleolus	μ^3	0,74±0,04	1,22±0,05*	2,07±0,07*	1,52±0,06*
Volume of cytoplasm	μ^3	49,7±2,4	99,6±4,9*	94,6±4,6	142,2±7,0*
Volume of endocrine granules	μ^3	6,38±0,32	7,16±0,35	7,94±0,39	10,58±0,5*
Volume of Golgi complex	μ^3	0,98±0,04	1,91±0,06*	3,4±0,09*	3,23±0,09
Volume of mitochondria	μ^3	2,58±0,07	2,95±0,08*	2,99±0,08	4,62±0,1*
Volume of lysosomes	μ^3	0,52±0,02	2,21±0,07*	1,51±0,06*	3,04±0,09*
Volume of vacuoles	μ^3	2,84±0,07	27,35±0,19*	24,49±0,19*	39,6±0,28*
Volume of lipid inclusions	μ^3	0,18±0,008	0,02±0,0001*	0,73±0,03*	0,51±0,02*
Number of endocrine granules in cell		189±8	321±16*	203±10*	261±13*
Number of granules in μ^3 of cytoplasm		3,8±0,15	3,2±0,15	2,2±0,1	1,8±0,1
CZC with high concentration of granules		31,3±1,2	25,2±1,2**	25,9±1,2	35,8±1,4*
CZC with low concentration of granules		23,2±0,9	28,8±1,4*	34,0±1,6**	35,8±1,6
Coefficient of crowding of granules in cytoplasm		1,42±0,07	0,89±0,04*	0,81±0,04	1,01±0,04*

Legend. *P ≤ 0.01 compared with previous experimental group, **P < 0.05 for the same. Other differences not statistically significant.

Comparison of these date with the cytochemical properties of granules of AL-cells discovered by the writers previously [6] indicates that lipid inclusions play an important role in the formation of the material of the granules. The reduction in the number of secretroy granules between the 1st and 10th minutes after stimulation can be explained, in our view, by activation of lysosomes and their more intensive agglomeration with the granules (Fig. 2), for neither exocytosis of the granules nor their cytoplasmic lysis could be observed. The high degree of crowding of the secretory granules before stimulation enabled the lysosomes to interact with many of them simultaneously, in the course of stimulation, after which the degree of crowding of the granules in the cytoplasm decreased. In that way, by contrast to other investigators [5, 15], we were able to characterize the phenomenon of "autophagy of granules" by the index of activation of secretion in the AL-cells and not by the index of destruction of accumulated "surplus" hormone. Meanwhile lysosomal enzymes are known to participate in prostaglandin formation [3].

Thus the lipolytic activity of the AL-cells which we found, when compared with data in the literature on release and functional properties of the prostaglandins and, allowing for the closely similar spatial relations of the AL-cells with the partietal and chief of the stomach, support the hypothesis that prostaglandins are formed in the AL-cells of the gastric mucosa, and a scheme of their secretory cycle (Fig. 3) can be postulated.

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