Structural and Metabolic Analysis of Gastric Mucosa in Gastropathies. Gastrobiopsy Data

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Bioptates of gastric mucosa are studied in gastropathies. Light and electron microscopic changes in the parenchymal and stromal compartments are described, and biosynthetic reactions and stereological parameters are evaluated, which are different in the fundal and pyloric regions.

Key Words: *gasrtopathy; gastrobiopsy; electron microscopy; radioautography; stereology*

The concept that nutrition and food must correspond to the evolutionarily formed natural technology of the assimilation processes [9] becomes now especially important due to considerable disturbances of biological systems in ecologically impacted regions accompanied by distribution of exotoxicants along the food chains [11] and penetration of xenobiotics into parenchymal and reproductive organs of animals and humans [6], the gastric mucosa being the entry and the site of metabolism for these xenobiotics. This induces specific reactive structural changes in the gastric wall which depend on the individual features of man and animals and their environment [2,8,10].

Clinical, endoscopic, and morphological investigations allowed us to define gastropathy as a clinicomorphological phenomenon. Unlike gastritis [1,4], gastropathy is not characterized by the classical signs of inflammation and represent a specific reaction of boundary tissues to adverse ecological factors [5].

The aim of the present study was a complex morphological investigation of gastric mucosa in gastropathies, including light and electron microscopy, *in vitro* radioautography, and morphometry.

MATERIALS AND METHODS

A total of 108 bioptates of gastric mucosa from the fundal and pyloric regions obtained from patients with gastropathy were studied and compared with 230 bioptates from patients with chronic gastritis (all specimens were obtained during fibrogastroscopy). The specimens were examined using light and electron microscopy and radioautography *in vitro*, and, in parallel, RNA and DNA synthesis in cell populations of gastric mucosa was assayed. A similar morphological analysis was described in details in [3]. Stereological analysis of gastric specimens was carried out on semithin sections using the multipurpose test system. Gastric mucosa was conventionally divided into superficial and deep layers in accordance with structural features. Primary stereological parameters characterizing structural density of the epithelium, capillaries, and connective tissue were calculated and used for computing secondary stereological parameters, which characterize the parenchyma-stroma ratio.

RESULTS

Light microscopy of biopsy specimens in gastropathies revealed that the main alterations in gastric mucosa were dystrophy and atrophy of parenchymal structures and diffuse sclerosis of mucosa; inflammatory cell infiltration was absent or inadequate to the degree and nature of sclerotic changes.

Fibrous changes in gastric mucosa were very intensive and widespread (Fig. 1, *a*), and even in young patients all layers of the mucosa were sclerous. In most cases the histoarchitectonics of the mucosa surface changed: it became villous. It should be noted that the degree of sclerosis correlated with

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TABLE 1. Radioautographic Analysis of RNA Syntheis in Gastric Mucosa in Gastropathies

No. of observartion	^{3}H-uridine labeling index					
	fundal region			pyloric region		
	SE	GE	endothelium	SE	GE	endothelium
298b87	4.3	-	-			
13b88	36.2	-	38.0			
15b88	14.1	13.8	14.2			
38b88	22.8	-	-	34.0	-	36.2
76b89	80.7	44.3	57.6	66.3	54.4	53.2
80b89	73.4	27.7	57.8	68.1	-	42.1
81b89	83.3	30.0	67.4	72.6	55.2	41.8

Note. SE: surface epithelium; GE: glandular epithelium.

structural changes in the glandular epithelium whose secretory function tended towards a decline. Only in few cases did we observe a combination of profound sclerosis and minor changes in the glands; the fundal groups preserved their differentiation and showed no marked dystrophic changes, being somewhat decreased in number.

The incidence of dystrophy of the surface epithelium was maximal in 45-55-year-old patients (93%). It should be noted that despite the increased incidence and severity of dystrophy of the epithelium, its mucigenous function was preserved. Consequently, the degree of dystrophic alterations of luminal epitheliocytes sometimes did not correspond to their functional activity, which may be attributed to enhanced compensatory and adaptive reactions of preserved structures [7]. The rate of epithelial dysplasia varied from 7 to 62% in different age groups, being maximal in 45-year-old patients. The rats of epithelial metaplasia also varied from 9 to 71%, being maximal in 46-55-year-old patients.

Ultrastructural analysis of bioptates revealed considerable similarity of changes in epithelial structures of the mucosa; however, the disturbances in the ultrastructural cell organization were more pronounced in profound sclerosis. The cytoplasm of glandulocytes was poorly structured, the cytoskeleton was disrupted, and the content of cell mucine was sharply decreased (Fig. 1, *b*).

Marked changes were also found in the ultrastructure of capillaries. Blood vessels were characterized by a very thin endothelial lining (Fig. 1, *c*). Endotheliocytes had very dark electron-dense cytoplasm, and organelles were hardly visible. The nucleus-containing portion of the cytoplasm protruded into the lumen and sometimes completely obstructed it. The amount of heterochromatin in the nuclei was increased, and nuclear membrane had relatively smooth contours without marked invaginations. The apical plasmalemma formed only occasional processes and invaginations. No signs of pinocytosis were observed. Scanning electron microscopy revealed disorganization of epithelial layer accompanied by a drop of secretory material on the mucosal surface (Fig. 1, *d*).

Radioautography showed very low RNA-synthesizing activity of the surface epithelium in both regions of the stomach in gastropathy (Table 1), this reduction of plastic functions being most pronounced in the fundal region. Moreover, a positive correlation was observed between the rate of RNA synthesis in epitheliocytes and endotheliocytes. The ^{3}H-thymidine labeling index varied from 6 to 19.8% in the fundal region and from 2.9 to 18.4% in the pyloric region of the stomach. Low proliferative activity of glandular epithelium indicated the development of atrophy. Changes in the intensity of incorporation of radiolabeled precursors correlated with the severity of structural damage [12].

Analysis of quantitative parameters of the main structural components of gastric mucosa in the fundal and pyloric regions showed that gastropathies were characterized by higher volume and surface density of luminal and glandular epithelium and capillaries (Table 2). These changes are probably due to a decreased thickness of the mucosa in gastropathies and the absence of edema. The rise of quantitative parameters in gastropathies is more pronounced in the pyloric region, indicating a more marked spatial reorganization of gastric mucosa. On the other hand, the volume and surface-volume ratios of capillaries to luminal and glandular epithelium in the fundal region is lower than in the pyloric region, which suggests some insufficiency of the microcirculatory bed in the fundal region.

Spatial reorganization of deeper layers of gastric mucosa (at the level of proper gastric glands) was

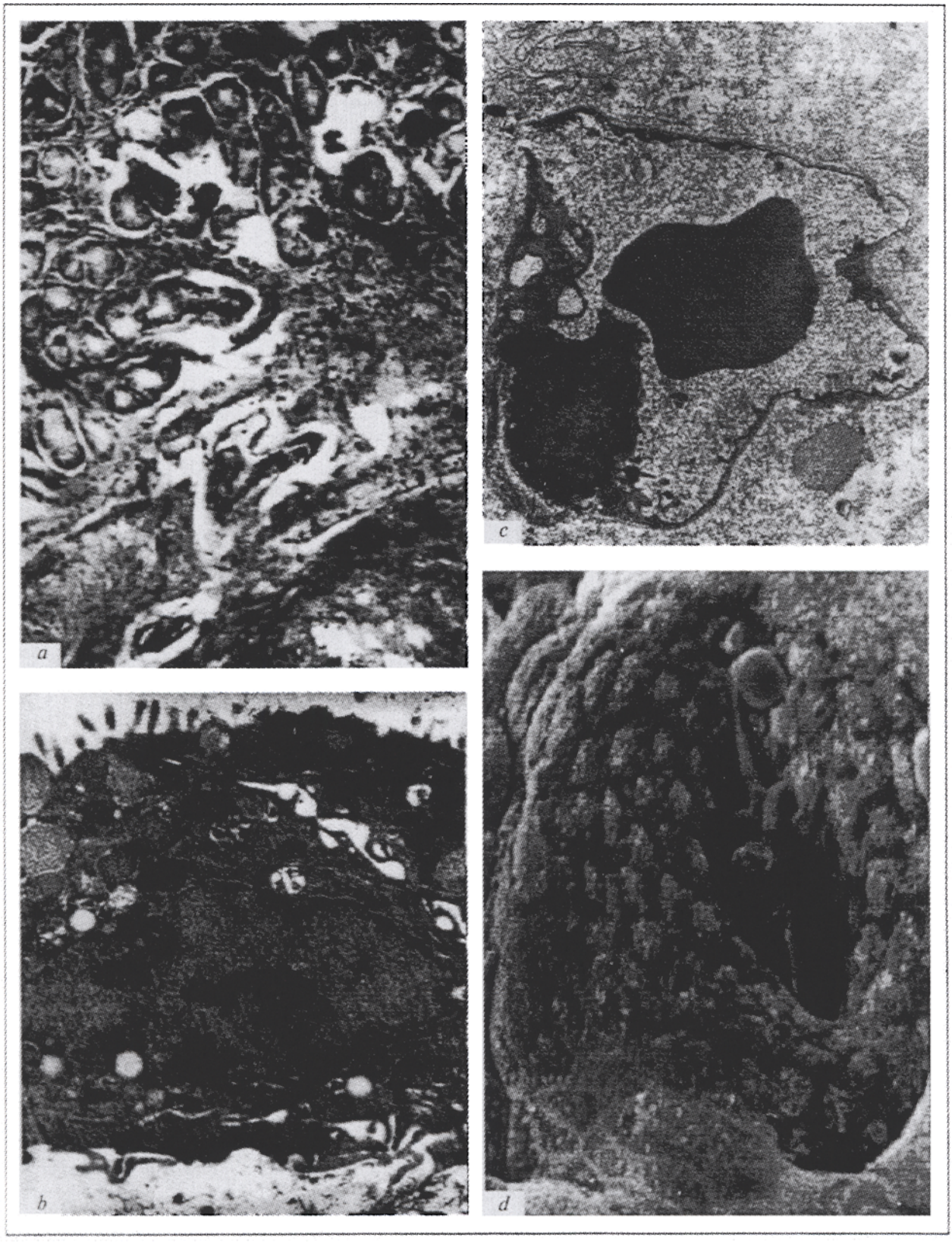

Fig. 1. Gastric mucosa in gastropathies. *a*) reduction of glands and intense sclerosis of the lamina propria. Van-Gieson staining, ×250; *b*) poorly structured cytoplasm of an epitheliocyte, solitary secretory granules, ×5000; *c*) blood capillary with very thin endothelial lining without the signs of pinocytosis, ×3300; *d*) disorganization of the epithelial monolayer. Scanning electron microscopy, ×5000.

TABLE 2. Stereological Parameters of Gastric Mucosa in Chronic Gastritis and Gastropathies (*M±m*)

Parameter	Chronic gastritis		Gastropathy	
	fundal region	pyloric region	fundal region	pyloric region
Superficial layer				
Surface-volume ratio, m^2/cm^3:				
luminal epithelium	0.086±0.006	0.107±0.004	0.087±0.004	0.113±0.005
capillaries	0.162±0.013	0.181±0.011	0.211±0.015	0.208±0.013
capillaries to luminal epithelium	0.024±0.002	0.028±0.002	0.029±0.002	0.039±0.007*
Volume ratio, number:				
capillaries to luminal epithelium	0.121±0.014	0.133±0.013	0.140±0.017	0.141±0.019
luminal epithelium to stroma	0.528±0.030	0.493±0.032	0.714±0.057*	0.653±0.041*
Deep layer				
Surface-volume ratio, m^2/cm^3:				
glandular epithelium	0.105±0.004	0.128±0.006	0.092±0.003	0.124±0.005
capillaries	0.312±0.012	0.486±0.017	0.202±0.018**	0.238±0.017***
capillaries to glandular epithelium	0.015±0.001	0.025±0.002	0.017±0.001	0.032±0.006
Volume ratio, number:				
capillaries to glandular epithelium	0.070±0.006	0.114±0.008	0.091±0.008	0.145±0.010
glandular epithelium to stroma	1.318±0.124	0.618±0.058	1.665±0.155	0.828±0.070

Note. *$p<0.05$, **$p<0.01$, ***$p<0.001$ in comparison with chronic gastritis.

similar to that of the surface layer. In gastropathies, the volume density of glandular epithelium increased but the surface density remained practically unchanged, which led to a slight decrease in the surface-volume density of glandular epithelium in comparison with chronic gastritis (Table 2). The volume density of capillaries rises more markedly in comparison with the surface layer, while their surface density increases to a lesser extent (by 32.3%), which results in a drop of the surface-volume density of capillaries and indirectly indicates their enlargement.

The volume and surface-volume ratio of capillaries to luminal and glandular epithelium are increased in gastropathies, although both in the superficial and profound layers this increase is of a low reliability level.

Thus, long-term exposure of gastric mucosa to adverse ecological factors results in specific structural alterations, among them the leading components are the atrophy of the epithelial compartment and the inhibition of metabolic and proliferative processes in cell populations of the gastric wall, which characterizes the development of regeneratory-plastic insufficiency. The parenchyma-stroma relationships under these conditions are realized in the development of diffuse stromal sclerosis and spatial reorganization of the mucosa consisting in relative insufficiency of the microcirculatory bed.

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