Metabolism of Sialic Acid-Containing Compounds in the Gastric and Intestinal Mucosa in Immobilization Stress

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The metabolism of sialoglycoproteins and ganglioside (free, oligo-, protein-, and lipid-bound sialic acids, and activity of sialidase) is studied in plasma and gastric and duodenal mucosa of rats subjected to immobilization stress for 8 days. Sustained alterations in these parameters are found in severely stressed animals.

Key Words: *sialic acids; glycoproteins; glycolipids; stress*

Sialic acids (SA), derivatives of neuraminic acid, are widespread in various tissues as constituents of sialoglycoproteins and gangliosides. These compounds are present in mucus and in the mucosa of the alimentary canal, where they perform a barrier function together with other compounds. Lipid-bound SA (LSA) are constituents of cell membranes. Meanwhile, erosions and ulcers of gastric and duodenal walls often develop under the influence of strong stress factors.

We studied the metabolism of SA-containing compounds in the gastric and duodenal wall in animals subjected to stress.

MATERIALS AND METHODS

Experiments were performed on male albino rats weighing 150-180 g (15 intact animals served as the control). The animals (n=72) were immobilized for 3 h on the back every day during an 8-day period. They were then sacrificed under ether anesthesia at different periods. The stomach and proximal part of the small intestine were isolated and their mucosae were washed with cold water and visually analyzed for the presence of erosions and ulcers. The adrenals were excised and weighed; the gastric and duodenal mucosae (glandular layer) were scraped with a scalpel. The contents of free, oligomer-, and protein-bound SA (FSA, OSA, and PSA, respectively) [7], LSA [9], sialidase activity (SDA) [6], and the level of 11-oxycorticosteroids [5] were measured in the plasma and alimentary canal mucosa (scrape).

RESULTS

An increase in the mass of the adrenals and in the blood content of 11-oxycorticosteroids (by 30% and higher) as well as the presence of erosions and ulcers in the stomach wall were considered as criteria of severe stress. According to these criteria, 25, 80, 50, and 10% of the animals endured severe stress on days 1, 3, 5, and 8, respectively.

The chosen experimental conditions caused no pronounced lesions damage of the duodenal mucosa, which is consistent with the published data [2,4].

The level of SDA and the contents of all the studied SA forms in the plasma increased progressively (by 13-215%) up to the 3rd day, after which the rate of changes slowed down (Table 1). The dynamics of FSA, OSA, PSA, and SDA activity in the gastric and duodenal mucosa was the same, with the exception of a transient decrease in the PSA content in the gastric mucosa on day 3 of

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TABLE 1. Content of Free and Bound SA in the Gastric and Duodenal Mucosae of Rats Subjected to Immobilization Stress ($M \pm m$)

Experimental conditions	Number of animals	FSA	OSA	PSA	LSA	SDA, mg/h/100 g dry tissue
		mg/liter				
Plasma						
Control	15	33.1±1.1	62.7±1.0	572±9	120±10	traces
Immobilization						
1 day	18	43.5±1.2*	73.9±1.7*	950±31*	188±9*	0.86±0.09*
3 days	15	56.4±1.3*	100±4*	1176±59*	379±24*	1.47±0.18*
5 days	14	52.5±1.2*	95.1±4.4*	861±30*	332±12*	1.07±0.04*
8 days	14	45.8±1.1*	95.1±4.6*	753±6*	234±10*	0.93±0.09*
Gastric mucosa, mg/kg dry tissue						
Control	15	22.6±0.9	274±10	3053±11	167±25	traces
Immobilization						
1 day	10	30.4±1.1*	347±12*	2769±119	140±9*	0.96±0.08*
3 days	9	31.9±1.3*	336±11*	2241±115*	142±9*	1.56±0.04*
5 days	8	26.3±0.8	307±9	3217±240	349±37*	0.57±0.03*
8 days	8	21.8±0.7	382±20	3351±160*	150±8	0.26±0.03*
Duodenal mucosa, mg/kg dry tissue						
Control	15	38.9±1.8	346±13	3963±131	147±20	0.73±0.16
Immobilization						
1 day	18	50.5±5.2*	347±20	4821±148*	106±4*	2.36±0.22*
3 days	15	63.5±4.3*	490±24*	5374±157*	167±22	3.05±0.12*
5 days	14	48.3±4.7*	452±24*	5112±142*	238±28*	3.66±0.51*
8 days	14	44.2±3.0	394±20*	3876±139	164±14	2.53±0.37*

Note. Asterisk indicates $p<0.05$.

immobilization. The LSA level in gastric and duodenal mucosa dropped on day 1 and rose 113 and 162%, respectively, on days 3-5. In the gastric mucosa the LSA level was restored and increased only by the 5th day (Table 1).

It is known that a strong stressor induces a sharp increase in blood catecholamines and corticosteroids. The latter are known to stimulate lysosomal enzymes and catabolism of the connective-tissue biopolymers [1,4]. This may account for the increase in SDA and in the products of sialoglycoprotein and ganglioside degradation in the gastric and duodenal mucosae. Analysis of these data shows that the sharp increase in the intensity of catabolic manifestations on day 3 of stress is accompanied by the appearance of gastric erosions and ulcers in 80% of the experimental animals.

In stress, an increase in the rate of degradation of proteins and ribosomal RNA in all organs goes along with the suppression of RNA and protein biosynthesis [3], which reduces the rate of physiological regeneration of cells. This should result in damage above all to rapidly renewed tissues. From this point of view, the appearance of stress-induced erosions and ulcers in the gastric mucosa, the epithelium of which is renewed much more rapidly than in the small intestine [8,10], is quite understandable. The decrease in the LSA content in the alimentary canal mucosa observed on the first day of immobilization and the more rapid restoration (the third day) of its level in the small intestine mucosa does not contradict the above statement.

Thus, repeated stress induces sustained deviations in the metabolism of the sialic acid-containing compounds in the gastric and small-intestine mucosae. The shifts in the plasma content of LSA and sialoglycans may be proposed as tests providing information regarding the state of the alimentary canal mucosa under stress.

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