

PHYSIOLOGY

CORRELATION BETWEEN CHANGES IN HIGHER NERVOUS ACTIVITY AND THE SECRETORY FUNCTION OF THE STOMACH DURING B₁-AVITAMINOSIS IN DOGS

L. A. Shekun

Laboratory of Digestive Physiology and Pathology (Head — Active Member Acad. Med. Sci. USSR I. P. Razenkov*), Institute of Normal and Pathological Physiology (Director — Active Member Acad. Med. Sci. USSR V. N. Chernigovskii) Academy of Medical Sciences USSR, Moscow

(Received November 6, 1957. Presented by Active Member Acad. Med. Sci. USSR V. N. Chernigovskii)

A description was given in a previous communication [5] of the main consistent changes in gastric secretion in dogs during the development of B₁-avitaminosis and during the subsequent period of vitamin therapy. We showed that B₁-avitaminosis caused marked disturbances of the secretory activity of the gastric glands. It was also established that systematic vitamin B₁ therapy diminished the clinical manifestations of the avitaminosis and led to the return of the impaired gastric secretion to a nearly normal level.

Our further investigations showed that repeated vitamin B₁ deficiencies were associated with still more marked disturbances of gastric gland function with diminution of secretion. In the profound stages of this condition there is almost complete depression of gastric secretion, which is only slowly restored, despite vitamin therapy [4].

Comparison of the results of physiologic investigations with the histologic data showing absence of organic lesions of the glandular cells of gastric mucosa suggested that the impairment of secretory activity of the gastric glands in vitamin B₁ deficiency was of functional character and resulted from impairment of nervous regulatory mechanisms.

It is known from the literature, and has been demonstrated by our studies, that a vitamin B₁ deficit causes considerable disturbances in bodily functions. It is also known [3] that vitamin B₁ plays a most important role in metabolism, in particular the metabolism of various tissues, such as nerve, gland etc. Metabolic disturbances in glandular tissue may be implicated in the development of changes in the gastric secretory function observed by us during vitamin B₁ deficiency. It could be supposed that vitamin B₁ deficiency in the organism elicited gastric secretory dysfunction by this means and also by way of changes in the central nervous system and its highest level, viz., the cerebral cortex. L.O. Zeval'd studied the effect of vitamin B₁ deficiency on the conditioned reflex activity in dogs and found that as the result of such deficiency there were marked disturbances of conditioned reflex activity which continued for a long time, even after termination of the vitamin deficiency [1].

Following the determination of the main consistent changes in gastric secretion during vitamin B₁ deficiency we attempted to analyze the mechanism of the observed disturbances associated with this pathologic process. Consequently, it was necessary first of all to discover the correlation between disturbances of higher nervous activity and the secretory function of the stomach in the same experimental dogs during the development of vitamin B₁ deficiency.

EXPERIMENTAL METHOD

Experiments were performed on dogs with isolated gastric pouches (Brestkin-Savich) and parotid gland fistulas.

* Deceased.

The effect of B₁-avitaminosis on gastric secretion and on higher nervous activity was studied. Experiments concerned with gastric secretion and with conditioned reflex activity were staged alternately, every other day. A background was first established; subsequently the clinical picture of developing avitaminosis was recorded systematically.

Induction of experimental vitamin B₁ deficiency in dogs has been described in detail previously [2]. In the present work, results obtained on the dogs Zhuk and Mal'chik are described; the vitamin deficiency was induced in these animals repeatedly (for the third and fourth time) by maintaining them on a saccharose-casein diet, free from vitamin B₁, as described in previous experiments.

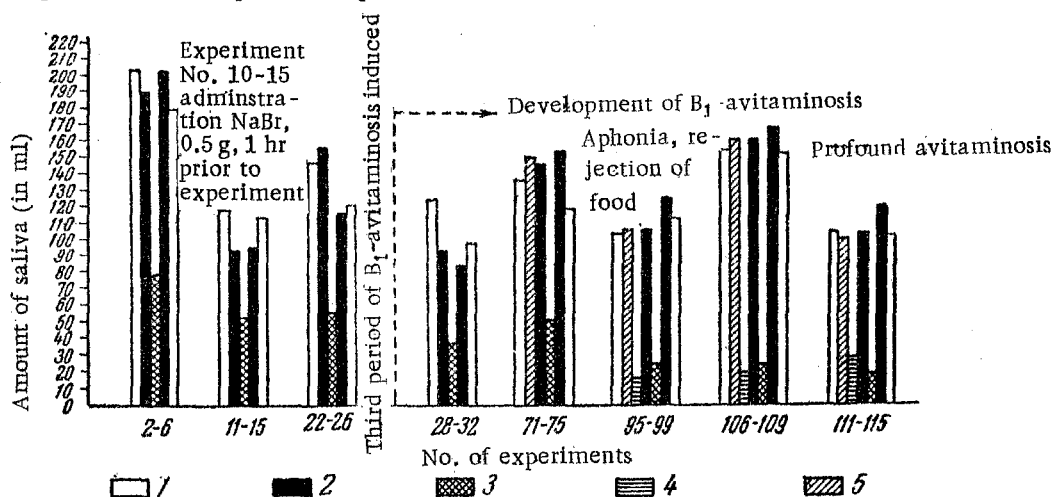


Fig. 1. Higher nervous activity of the dog Zhuk during the recovery period following the second period of B₁-avitaminosis and during the development of the third period of B₁-avitaminosis (arithmetic mean values of conditioned reflexes in 5 experiments).

1) Light; 2) M₁₂₀; 3) M₆₀; 4) buzzer; 5) bell.

In our first communication we described the experimental procedure for studying gastric secretion. The method of formation and investigation of conditioned reflexes was the usual one practised in I. P. Pavlov laboratories. Investigations of the higher nervous activity of the dogs Zhuk and Mal'chik were begun during the period of recovery, after vitamin therapy when the clinical manifestations of avitaminosis had disappeared. Conditioned stimuli included light, metronome at the rate of 120 strokes per minute (M₁₂₀) and metronome at the rate of 60 strokes per minute (M₆₀, differentiation). Then during the development of avitaminosis two new conditioned stimuli were introduced; a bell and a differentiation stimulus, viz., a buzzer. The conditioned stimuli were used in a stereotyped order (Fig. 1). The amount of saliva secreted was recorded on the scale.

When a more or less stable system of positive and negative reflexes had been established in the experimental dogs they were again put on the avitaminosis regimen — saccharose-casein diet.

EXPERIMENTAL RESULTS

Experimental data obtained on the dog Zhuk (Figs. 1 and 2) will serve to illustrate the main results of investigation of higher nervous activity and gastric secretion during vitamin B₁ deficiency.

Fig. 1 shows the arithmetic mean values of the conditioned reflexes obtained in 5 experiments during various periods of the investigation in Zhuk, extending over 1 year and 2 days (January 29, 1952 to January 31, 1953). The mean values of experiments characteristic for the given period of illness are given. Fig. 2 presents the mean arithmetic values of Zhuk's gastric secretion during the same periods.

Zhuk, who had sustained B₁-avitaminosis twice and had been in a recovery period for 3 months and 8 days, and was apparently quite healthy, showed impairment of strength relationships during the action of positive conditioned stimuli (light and M₁₂₀), and incomplete differentiation to M₆₀ (experiments Nos. 2-6). Complete differentiation could not be established after a 10-day period of sodium bromide administration to the dog (0.5 g in milk one hour prior to experiment), when the value of the positive reflexes diminished. When the value of conditioned re-

flexes approached relatively normal levels (experiments No. 22-26) the dog was put on the saccharose-casein diet for the third time.

From the very first days of the avitaminosis regimen the dog showed lower values of conditioned reflexes, paradoxical relations between the values of conditioned reflexes to light and M_{120} (experiments No. 28-32), and lowering of gastric secretion from 7.1-4.8 to 2.4 ml in response to meat, and from 5-8.5 to 3.7-1.9 ml in response to alcohol (Fig. 2).

The dog's behavior was unstable during the subsequent period of avitaminosis development: marked excitation alternated with sluggishness, increased appetite with refusal to take food. During this stage of the illness considerable fluctuations in the amount of gastric juice were noted, as well as changes in the latent period of secretion, acidity and digestive ability of the juice in response to both stimuli (Fig. 2) and substantial fluctuations in the values of the conditioned reflexes (Fig. 1).

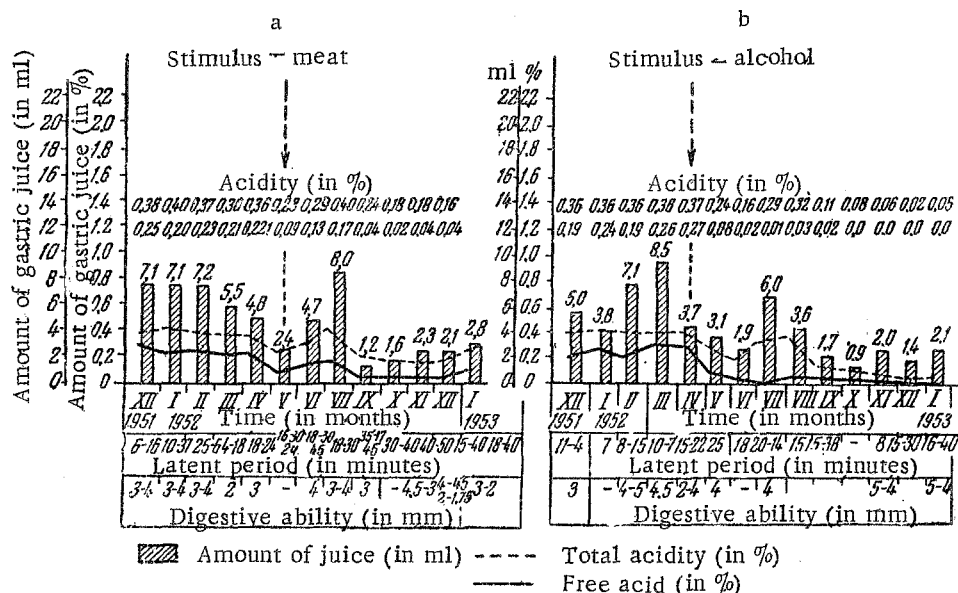


Fig. 2. Gastric secretion in the dog Zhuk during the recovery period following repeated B_1 -avitaminosis and during the development of the third period of B_1 -avitaminosis.

a) Gastric secretion in response to 100 g autoclaved meat (vertical broken line divides the recovery period after the second bout of B_1 -avitaminosis from the B_1 -avitaminosis induced for the third time); amount of juice - arithmetic means of experiments staged during the months; acidity - arithmetic mean of the same experiments; latent period and digestive ability - also for the month with fluctuations; b) gastric secretion in response to 100 ml 10% alcohol. (Designations the same as in Fig. 2, a).

During the 5th month of the development of avitaminosis a new conditioned stimulus, a bell, was introduced into the previously elaborated system. In the first 5 experiments marked fluctuations in the magnitude of the conditioned reflexes were noted, but in the 6th experiment the reflex to the bell had already become more or less stable in value. During the 6th month of the illness, when profound B_1 -avitaminosis had developed and the magnitude of all the conditioned reflexes had diminished, a differentiation stimulus with respect to the bell, viz., a buzzer, was introduced into the system of conditioned stimuli. Records of 2 experiments are presented in the table.

Changes in higher nervous activity and secretory function of the stomach during repeated B_1 -avitaminosis have been considered in the case of one of our experimental dogs. Basically similar data, but with even greater depression of gastric secretion, were obtained in the experiments on the dog Mal'chik.

Analysis of the experimental results indicates that repeated avitaminosis evokes definite changes in cerebral cortical function. These changes consist mainly of impaired relationship between excitation and inhibition. During the stage of development of profound avitaminosis weakening of both excitation and inhibition is noted from the marked drop in the values of positive conditioned reflexes, disinhibition of differentiations and phasic states.

The experiments also showed that during repeated B₁-avitaminosis new conditioned reflexes (bell and buzzer) could be formed by dogs even during profound vitamin B₁ deficiency.

Experimental Data Obtained on the Dog Zhuk

Interval in seconds	Number of combinations	Conditioned stimulus	Latent period in seconds	Amount of secretion		Remarks
				Conditioned	Unconditioned	

Experiment No. 96, 12/2/1952

5	296	+ Light	2	165	200	Zhuk during the development of third period of avitaminosis. Dog very ill
5	33	+ Bell	2	145	200	
5	17	— Buzzer	10	30	25	
5	191	+ M ₁₂₀	4	120	300	
5	95	— M ₆₀	28	5	10	
5	192	+ M ₁₂₀	3	125	300	
5	297	+ Light	3	130	280	

Experiment No. 97, 12/4/1952

5	298	Light	3	70	280	Dog very ill
5	34	Bell	3	30	275	
5	18	Buzzer	20	10	5	
5	193	M ₁₂₀	5	70	300	
5	96	M ₆₀	30	0	10	
5	194	M ₁₂₀	6	65	290	
5	299	Light	3	50	270	

Repeatedly induced B₁-avitaminosis leads to marked disturbances of gastric secretory function in dogs. During the development of avitaminosis sharp fluctuations in gastric secretion (hypersecretion and hyposecretion) are observed, as well as changes in the qualitative composition of the gastric juice. During the stage of profound avitaminosis secretion is inhibited. Comparison of changes in higher nervous activity with changes in gastric secretion during the development of B₁-avitaminosis shows that their onset is, as a rule, simultaneous.

During the recovery period the conditioned reflex activity of the salivary glands returns to normal more rapidly than the secretory function of the gastric glands.

The aim of our further investigations is to discover which disturbances of nervous regulation lead to disorders of gastric secretory function with a given pathologic process.

SUMMARY

The author studied the effect of B₁-avitaminosis on the higher nervous activity and the secretory function of the stomach in the same experimental animals. Experiments performed on dogs with an isolated stomach pouch and fistula of the parotid gland demonstrated that B₁-avitaminosis, induced repeatedly, brought about significant disturbances of the higher nervous activity, manifested by decrease of the value of positive conditioned reflexes, disinhibition of differentiations in the phasic conditions, as well as by significant disturbances of the secretory function of the gastric glands. The study of changes occurring in higher nervous activity and changes of gastric secretion, during the development of B₁-avitaminosis demonstrated that they appeared, as a rule, simultaneously.

LITERATURE CITED

[1] L. O. Zeval'd, In the book: Transactions of the I.P. Pavlov Physiologic Laboratories, * Moscow-Leningrad, 1948, vol. 14, pp.159-165; 1949, vol. 16, pp.253-258, 259-262.

* In Russian.

- [2] I. P. Razenkov, L. A. Shekun, *Biull. Eksptl. Biol. i Med.* 28, No. 3 (9), 220-225 (1949).
- [3] S. M. Ryss, *Vitamins (Physiologic Action, Metabolism, Therapy)*. * Leningrad, 1955.
- [4] L. A. Shekun, In book: *Transactions of Scientific Conference on the Problems of Digestive Physiology and Pathology*, * Moscow-Leningrad, 1954, pp.297-305.
- [5] L. A. Shekun, *Biull. Eksptl. Biol. i Med.* No. 7, 45-49 (1957).**

* In Russian.

** Original Russian pagination. See C. B. translation.