THE FUNCTIONAL STATE OF THE PITUITARY-ADRENAL SYSTEM DURING DIGESTION

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During recent years the attention of clinical and experimental workers has been drawn to the system of the pituitary and adrenal cortex, with its ability to affect various functions of the body. Evidence has been obtained showing that a close connection exists between this system and the secretory function of the stomach in certain pathological states [1-8, 10-14, and others]. However, we have found no mention in the literature of studies of the function of the pituitary and adrenal cortex during the period of normal digestion.

Our interest was therefore aroused in the study of the activity of the pituitary-adrenal system in the various stages of digestive secretion in response to different food stimuli. For this purpose we carried out chronic experiments on dogs.

EXPERIMENTAL METHOD

The functional state of the adrenal cortex was determined from the eosinophil count and the plasma 17-hydroxycorticosteroid concentration of the peripheral blood. The concentration of 17-hydroxycorticosteroids in the plasma was determined by the method of Silber and Porter [13], as modified by N. A. Yudaev and Yu. A. Pankov [9]. Experiments were carried out on three dogs: Seryi and Volchok (males) and Pal'ma (female), each animal having a Basow's fistula. As food stimuli we gave meat (200 g), milk (0.5 liter), and bread (0.5 kg).

Between 16 and 18 hours after their last meal, the dogs were fastened to the bench and the first blood sample was taken (from the great saphenous vein). The corticosteroid concentration in this sample was taken as normal. One hour after the blood was taken, the dogs received a food stimulus (meat, milk or bread). Subsequent blood samples were taken 30 min, and 2 and 4 hours after administration of this food stimulus.

EXPERIMENTAL RESULTS

The object of the first series of experiments was to study the state of the pituitary-adrenal system during digestion following administration of meat to the animals. The results of the experiments on the dog Seryi are shown in Table 1.

The changes observed in the other animals were similar in character, although there were differences in the degree of activation of the pituitary-adrenal system (Figs. 1 and 2).

Experiments to study the concentration of 17-hydroxycorticosteroids during digestion after administration of milk to the animals were conducted on the dogs Seryi and Pal'ma. It will be clear from Table 2 that the increase in the corticosteroid concentration in this series of experiments (the dog Seryi) was smaller than after administration of meat. Still lower figures were obtained for the corticosteroid concentration in the dog Pal'ma: 30 min after feeding – 153% (just over half that observed after administration of meat), 2 h after feeding – 123%, and at the end of the fourth hour – 108%.

In the next series of experiments bread was used as the food stimulus. An increase in the concentration of 17-hydroxycorticosteroids was observed in this case also, but it was even smaller than after administration of milk (Table 3). The results obtained with the other dogs were very close to those given in Table 3.

TABLE 1. Concentration of 17-Hydroxycorticosteroids (in μg/100 ml of plasma) after Administration of Meat as a Food Stimulus

Experiment No.	Before eating	After administration of meat		
		30 min	2 h	4 h
1	1,056	—	—	—
2	1,944	6,295	4,936	2,700
3	1,750	6,275	4,900	2,860
4	2,208	6,624	6,624	2,800
5	1,056	5,280	3,900	2,760
6	2,224	6,950	4,170	2,780
Mean	1,706±0,18 (100%)	6,285±0,31 (367%)	4,918±0,17 (288%)	2,780±0,2 (152%)

TABLE 2. Concentration of 17-Hydroxycorticosteroids (in μg/100 ml of plasma) after Administration of Milk as Food Stimulus

Experiment No.	Before eating	After administration of milk		
		30 min	2 h	4 h
1	1,110	2,930	1,900	1,830
2	1,420	2,710	1,960	1,840
3	1,870	2,220	2,040	2,000
4	1,670	2,410	2,100	1,780
5	2,140	4,100	2,000	1,980
Mean	1,630±0,39 (100%)	2,870±0,57 (175%)	2,000±0,07 (123%)	1,886±0,09 (115%)

TABLE 3. Concentration of 17-Hydroxycorticosteroids (in μg/100 ml of plasma) after Administration of Bread as Food Stimulus

Experiment No.	Before eating	After administration of bread		
		30 min	2 h	4 h
1	1,110	2,980	1,870	1,710
2	1,420	2,600	1,910	1,560
3	1,870	2,170	2,010	1,800
4	1,610	2,420	2,000	1,800
5	2,140	3,430	2,110	1,930
Mean	1,630±31 (100%)	2,720±0,10 (167%)	1,980±0,05 (121%)	1,760±0,02 (108%)

These experiments showed that all food stimuli lead to an increase in the 17-hydroxycorticosteroid concentration in the blood and to a decrease in the eosinophil count. Consequently, the pituitary-adrenal system is activated by the administration of food. The most marked reaction was observed during the first 2 hours after administration of the food stimuli (in the reflex phase of gastric secretion). These findings prompted us to study the state of the pituitary-adrenal system at different stages of digestion. For this purpose we carried out two series of experiments. In the first series we studied the concentration of 17-hydroxycorticosteroids in the blood of a gastro-esophagotomized dog during sham feeding, i.e., during the conditioned-reflex phase of gastric secretion, and in the second series of experiments we made similar studies after introducing a food stimulus directly into the stomach (through the fistula), i.e., in the second, or neurohumoral phase of gastric secretion.

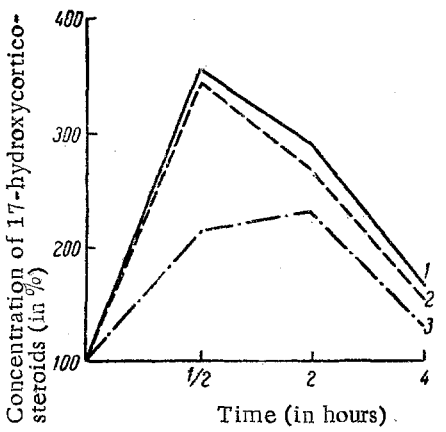

Fig. 1. Concentration of 17-hydroxycorticosteroids in the blood plasma of dogs. 1) Seryi, 2) Pal'ma, 3) Volchok.

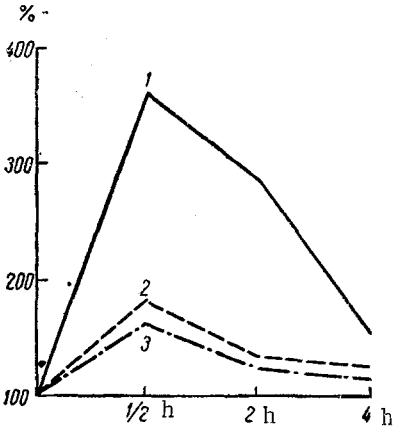

Fig. 2. Concentration of 17-hydroxycorticosteroids in the blood plasma of the dog Seryi after determination of different food stimuli: 1) meat, 2) milk, 3) bread.

Sham feeding experiments conducted on the dog Chernyi showed that the increase in 17-hydroxycorticosteroids in these conditions was considerable but transient: 30 min after feeding, the corticosteroid concentration had increased to 182%, but after 2 h it had fallen to 105%, and after 4 h to 104%. Similar results were obtained in experiments performed on Seryi and Pal'ma, during sham feeding with meat: 30 min – 176%, after 2 h – 109%, after 4 h – 102% (Seryi). The variation in the increase in the corticosteroid concentration in the dogs in these experiments corresponded to their different external reaction to the food stimulus (excitation at the sight of food).

It may be concluded from these investigations that the increase in the secretion of 17-hydroxycorticosteroids during the period of digestion is evidently the result of excitation (arising during the administration of food) of the vast number of receptors in the oral cavity and esophagus, and of the innumerable stimuli applied to the optic, olfactory, and gustatory apparatuses. These impulses, reaching the central nervous system, excite the food center; as a result of irradiation of the excitation a change occurs in the state of the hypothalamic region, and this, in turn, leads to excitation of the hypophysis and to an increase in the secretion of ACTH. This conclusion is confirmed by experiments in which the food stimulus (200 g of finely chopped meat) was introduced directly into the stomach through the fistula. These experiments were performed in conditions excluding the formation of efferent impulses. The increase in the concentration of 17-hydroxycorticosteroids in the blood became statistically significant only 2 h after feeding (118%), which can be attributed to the direct influence of products of digestion.

Our conclusion also agrees with the results of experiments in which food stimuli were applied repeatedly to the animals. In these experiments the increase in the concentration of 17-hydroxycorticosteroids was less marked but of longer duration than in the experiments in which the animals received food once only.

Hence we have shown that in the period of digestion stimulation of the function of the pituitary-adrenal system takes place, and is set in motion during the first hours by a reflex mechanism. In later periods this activation may be brought about by the action of products of digestion.

SUMMARY

The activity of the pituitary-adrenal system was determined by the number of 17-hydroxycorticosteroids and eosinophils in the blood. As demonstrated, nutritional stimuli (meat, milk, bread) caused a rise in the 17-hydroxycorticosteroid concentration and reduction in the number of eosinophils. The analysis of the mechanism of stimulation of the system demonstrated that its activation during digestion occurs under the effect of the reflex mechanisms. At later digestive periods this activation may be caused by the action of digestive products.

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All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.