

LEVELS OF 17-HYDROXYCORTICOSTEROIDS IN BLOOD PLASMA
OF RHESUS MONKEYS AND HAMADRYAS BABOONS AND CHANGES
CAUSED BY NEURO-EMOTIONAL ACTION

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The literature contains data on the hormonal function of the adrenal cortex in monkeys but they are few and have been obtained mainly with rhesus monkeys [6, 9].

The aim of the present work was to estimate normal values for adrenal cortex hormones in 2 species of monkey, rhesus monkeys and hamadryas baboons, and also to study the reaction of the adrenal cortex in monkeys to the injection of adrenocorticotrophic hormone, neuro-emotional stress, and physical stresses.

EXPERIMENTAL METHOD

In earlier work we found that the adrenals of hamadryas baboons and rhesus monkeys secrete mostly 17-hydroxycorticosterone (hydrocortisone). The hormone activity of the adrenal cortex was therefore evaluated by the content of 17-hydroxycorticosteroids in blood plasma.

17-Hydroxycorticosteroids were estimated in 1.5 ml plasma by the method of Porter and Silber modified by N. A. Yudaev and Yu. A. Pankov [5]. This method permits the estimation only of those corticosteroids with an OH group at C₁₇, i. e., 17-hydroxycorticosterone.

To estimate the 17-hydroxycorticosteroids 3.5-4 ml blood was taken.

The trials in which normal values for 17-hydroxycorticosteroids were estimated in monkeys were on 30 sexually mature rhesus monkeys and hamadryas baboons of both sexes, and also on 16 immature rhesus monkeys.

The effect of adrenocorticotrophic hormone on adrenal cortex activity was studied in 8 adult monkeys: 4 hamadryas baboons and 4 rhesus monkeys (males). ACTH (Sanabo) was injected intravenously at a rate of 1 unit per kg bodyweight.

The effect on adrenal cortex function of neuro-emotional stress caused by stopping the trial and separating the males from the females for 1½-2 h was studied in adult males, 4 hamadryas baboons and 4 rhesus monkeys. The reaction of the cortical layer of the adrenals to the action of surgical trauma while under nembutal narcosis was studied in 6 hamadryas baboons and rhesus monkeys. The operation consisted of obtaining blood flowing from the adrenal.

The effect of physical effort (15-20 min running in a rotating wheel) on adrenal cortex activity was studied in 5 hamadryas baboons.

RESULTS

The results of the trials in which normal values for 17-hydroxycorticosteroids in monkeys studied are presented in Table 1.

TABLE 1. 17-Hydroxycorticosteroids in Blood Plasma of Monkeys (in μg per 100 ml Plasma)

Group of animals	No. of observations	No. of animals	M \pm m
Sexually mature hamadryas baboons:			
males	41	4	41 \pm 1.5
females	85	12	52 \pm 1.5
Sexually mature rhesus monkeys:			
males	39	4	34 \pm 3
females	40	10	44 \pm 1.2
Immature rhesus monkeys	89	18	51 \pm 1.7

Table 1 shows that there was far more 17-hydroxycorticosteroids in female rhesus monkeys and hamadryas baboons than in males and more in immature rhesus monkeys than in adult monkeys of that species.

The data on the high concentration of 17-hydroxycorticosteroids in females and the relatively low concentration in males agree with findings in the literature on the ability of estrogens to increase the level of corticosteroids in blood plasma and on the inhibitory effect of male sex hormones on adrenal cortex activity [3, 11, 14, 15].

Estimation of 17-hydroxycorticosteroids during a day showed (Fig. 1), that the highest values occur from 9 a.m. to noon, then gradually fall, more rapidly in rhesus monkeys than in hamadryas baboons.

The diurnal behavior of 17-hydroxycorticosteroids in the blood plasma of monkeys established by us is confirmed by findings in the literature [9].

Figure 2 shows that in rhesus monkeys the greatest increase in concentration of 17-hydroxycorticosteroids in response to injection of ACTH was observed one hour after injection, whereas in hamadryas baboons the maximum values were found 2-3 h after injection of ACTH. The amount of 17-hydroxycorticosteroids in blood increased more considerably in hamadryas baboons than in rhesus monkeys. One can speculate on the differing sensitivity of the cortical layer of the adrenals of monkeys of different species to exogenous ACTH.

At the beginning of the trial the level of 17-hydroxycorticosteroids was increased in the monkeys. As the orientation defense reaction is reduced, the amount of 17-hydroxycorticosteroids falls also.

The neuro-emotional stress in the males caused by separating them from the females is accompanied by an increase in blood plasma 17-hydroxycorticosteroids (Fig. 3). Statistical analysis of the experimental results showed a significant increase in the level of corticosteroids in all the monkeys except for the male Turgos (see Fig. 3), in which no emotional reaction to separation from the females was noted.

The marked increase in the 17-hydroxycorticosteroid content of the monkeys during neuro-emotional stress indicates the participation of the higher sections of the central nervous system in the regulation of the function of the pituitary-adrenal system.

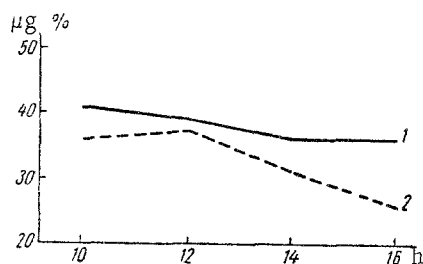


Fig. 1. 17-Hydroxycorticosteroids (in μg %) in monkeys at different times of the day: 1) hamadryas baboons; 2) rhesus monkeys. Each point is the mean of 8-40 estimations.

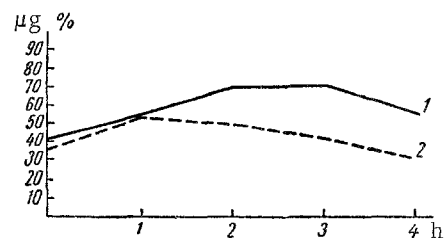


Fig. 2. Reaction of monkey adrenal cortex to injection of ACTH. On axis of abscissae — time from ACTH injection (in h). Each point is the mean of 4-12 estimations. Other notes as for Fig. 1.

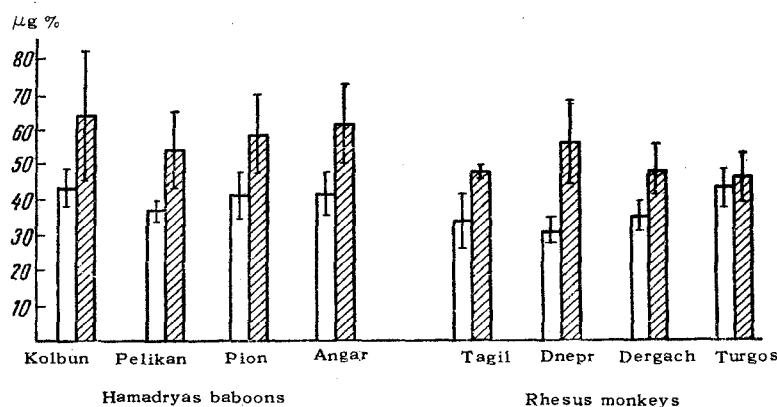


Fig. 3. Effect of neuro-emotional stress on blood plasma 17-hydroxycorticosteroids of monkeys (in $\mu\text{g } \%$). Plain columns) initial value; crosshatched) 2 h after separation of females from males. Each column is the mean of 5-10 estimations.

Findings on the adrenal cortex reaction of monkeys under nembutal narcosis to the effect of surgical trauma are presented in Table 2.

The behavior of the corticosteroids during surgery for obtaining blood from the adrenals, shown in Table 2, shows that adrenal cortex activity increases for the most part immediately before surgery and before narcosis. This increase may be considered a result of the orientation defense reaction of monkeys to being placed on the operating bench. After narcosis at the time of surgery a relatively small increase in 17-hydroxycorticosteroids is noted. This is connected with the fact that nembutal narcosis blocks the entry of nerve impulses into the hypothalamus, the nuclei of which, as is well-known [1, 10, 12, 13], produce a neurosecretion which stimulates the synthesis and secretion of ACTH in the adenohypophysis. Nembutal, in blocking the production of the neurosecretion, thereby inhibits secretion of ACTH, as a result of which the adrenal cortex does not receive adequate stimulus.

The results presented agree with those in the literature [2, 7, 8] on the inhibitory effect of barbiturates of the nembutal type during surgery on the activity of the hypothalamus – adenohypophysis – adrenal cortex system.

The results of the effect of physical stress on the activity of the pituitary – adrenal system of hamadryas baboons (females) are shown in Table 3.

The individual reaction of the monkeys can be clearly seen in Table 3: whereas the greatest increase in adrenal function in the first 2 animals occurs 60 min after a 20 min run, in the last 3 it was clearly observed after

TABLE 2. Effect of Surgical Trauma with Nembutal Narcosis on the Concentration of 17-Hydroxycorticosteroids in the Blood Plasma of Rhesus Monkeys and Hamadryas Baboons

Group of animals	Concentration of 17-hydroxycorticosteroids (in μg per 100 ml plasma)				
	initial	before surgery and before narcosis	during surgery		
			after 20 min	after 90 min	after 120 min
Rhesus monkeys: (Nos. 40, 98) . . .	40	—	61	53	67
Hamadryas baboons:					
Naut.	51	65	73	—	69
Zodiak	50	67	64	68	72
Éisen.	54	68	76	64	81
Lazurnik	55	70	—	—	65
Anyb.	52	—	59	99	87
$M \pm m$	50 ± 2.4	67 ± 1.2	67 ± 3.2	71 ± 11.1	73 ± 3.2

TABLE 3. Effect of Physical Stress on the Content of 17-Hydroxycorticosteroids in the Blood Plasma of Hamadryas Baboons (Females)

Name of animal	Concentration of 17-hydroxycorticosteroids (in μg per 100 ml plasma)		
	initial	after 15-20 min running	
		after 6 min	after 60 min
Naperstyanka . .	43	52	111
Néra	45	62	73
Kaliforniya . . .	49	93	98
Khna	52	103	100
Ineya	53	73	81
M \pm m	48 \pm 1.9	77 \pm 9.7	93 \pm 7.3

only 6 min. In these 3 trials, along with muscular stress, there was also a neuro-emotional factor associated with the orientation defense reaction of monkeys to the experimental conditions.

SUMMARY

Experiments were made by Porter and Silber's method in N. A. Yudaev and Yu. A. Pankov's modification to establish the normal level of 17-hydroxycorticosteroids in the blood plasma of monkeys. The concentration of 17-hydroxycorticosteroids in male rhesus macaques was on the average $34 \pm 1.3 \text{ mg } \%$, in females — $44 \pm 1.2 \text{ mg } \%$; in male and female hamadryads — $41 \pm 1.5 \text{ mg } \%$ and $52 \pm 1.5 \text{ mg } \%$ respectively.

Variable reaction of the adrenal cortex to intravenous injection of ACTH was found in different species of monkeys, in rhesus macaques the maximum increase in the amount of 17-hydroxycorticosteroids was registered one hour after the injection of the preparation, in hamadryads — in two hours.

Nembutal anesthesia prevents the development of the stress condition. It was found that the neuro-emotional strain in monkeys brings about a marked increase in the hormonal function of the adrenal cortex.

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