Biocycles of Kidney Excretory Function in Hypothyroid Patients

V. P. Pishak and N. V. Krivich

Translated from *Byulleten' Eksperimental'noi Biologii i Meditsiny*, Vol. 125, No. 6, pp. 684-687, June, 1998
Original article submitted May 12, 1997

Structural transformations of biological cycles of the kidney excretory function were found in hypothyroid patients. The appearance of new acrophases in daily cycle of diuresis and excretion of sodium, potassium, and creatinine accompanied with a decrement in their amplitudes testifies to inversion of the cycles.

Key Words: *hypothyrosis; excretion; biocycles*

A key function of daily biocycles is synchronization of physiological processes. The parameters of these cycles can be considered as independent characteristics of physiological status. As other organs and systems, the kidneys are characterized by a clear-cut cyclic activity.

Analysis of the substances excreted by the kidneys provides the data on rhythmic organization of various organs and systems, since they are the targets of system control functions [2]. Desynchronization of kidney activity occurs at the early stages of many diseases and precedes the physiological and morphological alternations.

Thyroid hormones directly affect the kidneys, as evidenced by accessibility of kidney receptors to thyroxin and triiodothyronine [8]. The kidneys are extremely sensitive to thyroid hormone deficiency.

Our aim was to study daily biocycles of kidney excretory function in patients with hypothyrosis (HT).

MATERIALS AND METHODS

We examined 28 HT patients and 20 healthy subjects (control group) at the age of 16-60 years. Diagnosis was based on clinical and laboratory data. All patients were examined before therapeutic prescriptions.

On the examination days the patients were recommended a unified sleep-wakefulness regime, four-time diet without limitation in water but with a moderate taking of table salt.

Urine was taken every 3 h during a day, and its volume was measured. Sodium and potassium were determined by flame photometry, and creatinine by the Popper test.

The results were analyzed using the cosinor analysis. The parameters were characterized by mean value, amplitude (the difference between maximum and mean values), and acrophase (the moment of maximum).

RESULTS

In the control, the nonapproximated plot of creatinine excretion had an elevation (coincided with acrophase, Table 1) and an additional smaller crest from 6.00 to 9.00 a.m. (Fig. 1). This agrees with the data that the acrophase of creatinuria in healthy subjects occurs at 6 a.m. and 6 p.m. [12].

Table 1 shows that in HT patients diuresis was decreased both in the mean value and even more strongly (almost by 2 times) in amplitude, while its acrophase was shifted to the night-time by approximately 9 h. The mean value of potassium excretion practically did not change, but there was a decrement in its amplitude and pronounced shift in the acrophase to the early morning period by 8.5 h.

The most pronounced changes were observed in the sodium excretion cycle. They were manifested in a drastic decrease in the mean value (by more than

Chernovitskii Medical Institute, Chernovtsy

0007-4888/98/0006-0608$20.00

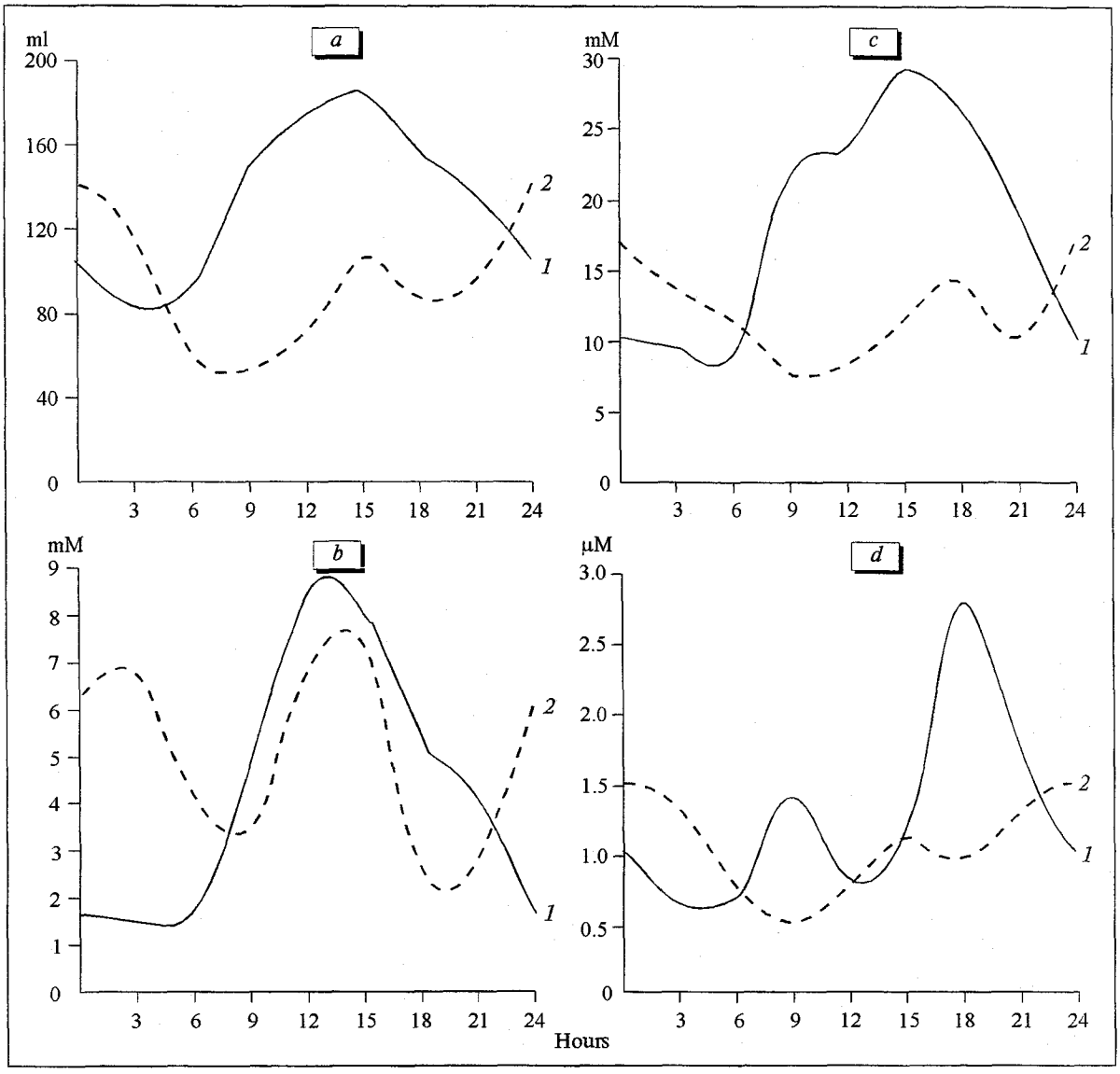

Fig. 1. Daily biocycles of (*a*) diuresis and excretion of (*b*) potassium, (*c*) sodium, (*d*) creatinine: (*1*) in healthy subjects and (*2*) in patients with hypothyrosis (initial data).

1.5 times) and in the amplitude (by more than 3 times) and in a shift of acrophase to the nighttime by 11 h. Creatinuria was characterized by a decrease in amplitude and a shift of acrophase to the nighttime by 6 h.

These changes testify to an almost complete inversion of the cycle of kidney excretory function in HT patients (Fig. 2). However, analysis of initial (nonapproximated) data (Fig. 2) revealed two peaks on the plots during daytime. The larger of them cor-

TABLE 1. Parameters of the Daily Biocycle of Kidney Excretory Function

Index	Control			HT Patients		
	mean	amplitude	acrophase	mean	amplitude	acrophase
Diuresis, ml	135	51	15 h 05 min	92	27	24 h 00 min
Potassium, mM	4.48	3.75	14 h 14 min	5.02	0.604	5 h 38 min
Sodium, mM	18.42	11.74	15 h 29 min	11.82	3.64	2 h 34 min
Creatinine, µM	1.261	0.673	17 h 48 min	1.017	0.365	24 h 00 min

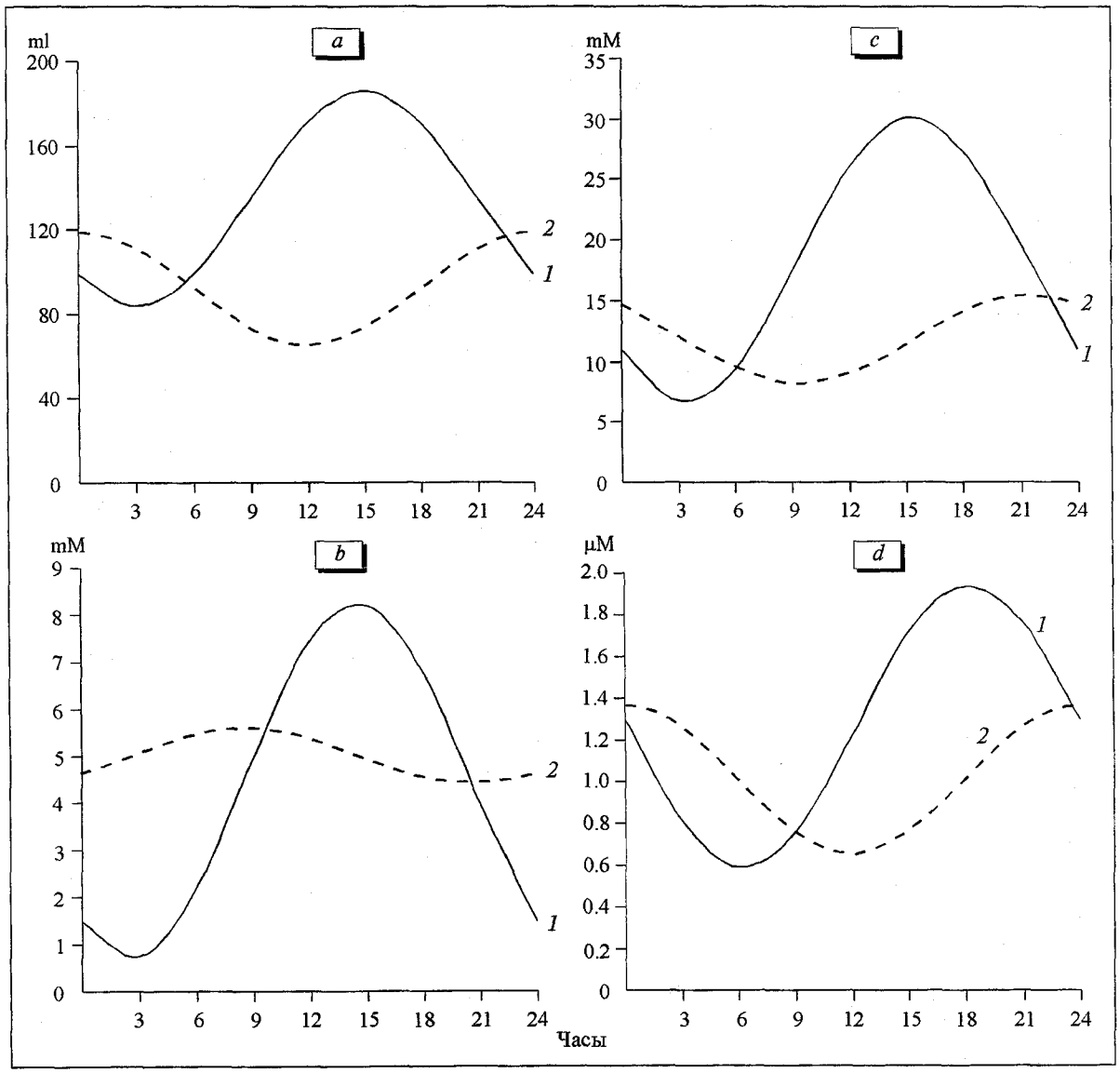

Fig. 2. Daily biocycles of (*a*) diuresis and excretion of (*b*) potassium, (c) sodium, (*d*) creatinine: (*1*) in healthy subjects and (*2*) in patients with hypothyrosis (approximated data).

responds to the above-mentioned acrophases, while the smaller is recorded in the period characteristic of the control group.

Therefore, in HT patients the appearance of new peaks of excretion is accompanied by a decrease in the heights of peaks characteristic of the control group.

Several mechanisms are responsible for the described desynchronization of excretory cycles. Patients with HT are characterized by changed secretion of vasopressin which in healthy subjects is elevated at night [7]. Under deficiency of thyroid hormones, secretion of vasopressin is increased during daytime [11], and decreased at night probably due to compensatory reaction.

It was reported that thyroidectomy lowered serum concentration of atrial natriuretic factor of hyper- and hypothyroid rats [13].

After thyroidectomy, the concentration of aldosterone decreaseds in rats [5]. However, plasma aldosterone levels remain normal in most HT patients [3].

The role of pineal gland in formation of biocycles in general and, specifically, in organizing cyclic operation of the kidney, is well established. This gland mediates the interactions of an organism and environment, which helps it follow the change of day and night. In this connection of particular interest are the disturbances of the pituitary-thyroid relations occurring in hypothyrosis. It was shown that hypothyrosis causes a drastic decrease in melatonin concentration [6,9].

Morphological alternations that take place in the kidneys during thyroid hormone deficiency should be taken into account. They are observed as changes in

the cells of any type (tubular, glomerular, and interstitial) accompanied by vacuolization, edema, appearance of the intracellular inclusions, and enhancement of the mesangial matrix [10].

Bearing in mind direct action of thyroid hormones on the kidneys, one can suppose that in HT patients the biocycles of thyroid gland and kidneys are interactive [1,4].

Presumably, all the considered mechanisms are involved in the genesis of desynchronization of daily cycles of kidney excretory function documented in HT patients.

REFERENCES

1. Yu. A. Romanov, O. P. Zaharchenko, L. I. Stepanova, and E. L. Kamenetskaya, *Probl. Endokrinol.*, **22**, No. 3, 113-117 (1976).
2. F. I. Komarov, (Ed.), *Chronobiology and Chronomedicine* [in Russian], (1989).
3. F. M. Egart, T. M. Atamanova and A. N. Nazarov, *Probl. Endokrinol.*, **32**, No. 1, 35-38 (1986).
4. R. Adriance, G. Brabant, K. Prank, *et al., Clin. Endocrinol.* (Oxford), **37**, No. 6, 504-510 (1992).
5. S. Avigdor, F. Alhenk-Gelas, and J. Bouhnivc, *Am. J. Physiol.*, **263**, No. 3, 430-434 (1992).
6. M. D. Catala, W. B. Qualg, G. R. Vibat, *et al., Neuroendocrinology*, No. 6, 376-388 (1987).
7. G. George, *J. Biol.*, **9**, No. 5, 346 (1982).
8. L. D. Kohn, S. M. Aloij, D. G. Tombaceini, *et al.*, in: *Biochemical Actions of Hormones,* Orlando (1985), Vol. 14, pp. 76-78.
9. E. S. Rom-Bugoslavskaya and A. Bondarenko, *Acta. Physiol. Hung.*, **70**, No. 4, 397-401 (1987).
10. M. I. Salomon, V. Discala, E. Grishman *et al., Metabolism.*, **16**, 846-852 (1967).
11. W. R. Skowsky and T. A. Kiruchi, *Am. J. Med.*, **64**, 613-621 (1978).
12. G. Steinbach, M. Hilfenhouse, H. Mayersbach, *et al., Arch. Toxicol.*, **36**, No. 3-4, 317-325 (1976).
13. N. L. Wong, D. Huang, N. S. Guo *et al., Am. J. Physiol.*, **256**, No. 1, 64-67 (1989).