

DIURNAL RHYTHM OF PARAMETERS OF EXTERNAL RESPIRATORY FUNCTION IN CLINICALLY HEALTHY PERSONS

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The diurnal rhythm of parameters of external respiratory function was studied in 67 clinically healthy persons aged from 20 to 62 years by spirometry and pneumotachometry. Tests were carried out 4 times a day: at 2 and 7 a.m., 12 noon, and 9 p.m. In the younger and middle-aged subjects a statistically significant decrease was found in the minute respiratory volume at night and an increase in the power of inspiration in the evening. The respiration rate, the O_2 consumption per minute, the maximal ventilation of the lungs and their vital capacity, the coefficient of oxygen utilization, and the power of expiration did not vary significantly during the 24-h period. In healthy subjects of the older group a significant decrease was found in the respiration rate, the maximal ventilation of the lungs, and the index of the rate of air movement at night; the minute volume of respiration was increased in the afternoon and evening and reduced at night, the values of Tiffeneau's test and the power of expiration were increased at midday, while the respiratory reserve was reduced in the afternoon and evening.

KEY WORDS: external respiration; diurnal rhythm of respiration.

About 75 different physiological functions characterized by a diurnal rhythm have now been studied in man [8]. The rhythm of diurnal fluctuations of some parameters of lipid metabolism and the hemodynamics has been studied [1, 3, 4, 6, 9]. However, very little attempt has been made to study the diurnal rhythm of the parameters of external respiration under normal and pathological conditions. Only a few papers describing investigations of the diurnal rhythm of some parameters of external respiration could be found in the accessible literature [5, 7, 9]. Meanwhile the study of the diurnal rhythm of the parameters of external respiratory function (ERF) could provide an indirect criterion of variation in the severity of congestive changes in the lungs in cardiac decompensation, the subject of clinical as well as theoretical interest. However, before the diurnal rhythm of fluctuations of ERF in patients with circulatory failure can be correctly assessed, the problem must first be studied in clinically healthy persons.

The present investigation was carried out for this purpose.

EXPERIMENTAL

Repeated determinations were made of the lung volumes and bronchial patency by means of spirometry and pneumotachometry. The tests were carried out 4 times a day: at 7 a.m. (under basal metabolic conditions), at noon, 9 p.m., and 2 a.m. The respiration rate (RR) per minute, the minute volume of respiration (MVR), the oxygen consumption per minute (OC), the vital capacity of the lungs (VCL), the maximal ventilation of the lungs (MVL), the respiratory reserve, the index of the rate of air movement (RAM), and the power of inspiration and expiration were studied. The values obtained for the lung volumes were reduced to volumes at 0°C and 760 mm Hg. The group of clinically healthy persons consisted of 67 individuals aged from 20 to 62 years, including 40 men and 27 women. Clinical, functional-diagnostic, and laboratory tests

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TABLE 1. Diurnal Rhythm of ERF Parameters in Clinically Healthy Persons Aged from 20 to 50 Years

Parameter of ERF	Time						
	7 a.m	12 noon	P	9 p.m	P	2 a.m	P
RR, per minute	15,9±0,45	15,7±0,48	0	16,3±0,49	0,3	15,7±0,44	0
MVR (in liters/min)	13,2±0,53	12,4±0,54	0,2	12,8±0,47	0,2	11,8±0,53	<0,05
OC (in ml/min)	244±9,6	251±9,2	0,2	286±38,6	0,1	227±9,9	0,2
COU (in ml/liter)	21,4±1,49	27,7±1,46	0,1	22,8±1,46	0,2	24±1,52	0,1
VCL (in liters)	4,0±0,17	4,0±0,03	0	3,9±0,12	0,3	4,0±0,12	0
MVL (in liters/min)	78,8±3,53	78,1±2,90	0	76,7±1,23	0,3	76,7±1,20	0,3
Respiratory reserve (in liters/min)	6,6±0,48	7,1±0,52	0,3	6,5±0,39	0	7,0±0,47	0,3
RAM (in liters/min/liter)	19±0,67	19,5±0,54	0	18,8±0,8	0,3	19,0±0,73	0
Power of: inspiration (in liters/sec)	4,2±0,16	4,2±0,18	0	4,6±0,76	<0,05	4,5±0,17	0,1
expiration (in liters/sec)	3,7±0,20	4,0±0,17	0	3,6±0,20	0	4,5±0,19	0,1

TABLE 2. Diurnal Rhythm of ERF Parameters in Healthy Persons Aged 50-62 Years

Parameter of ERF	Time						
	7 a.m	12 noon	P	9 p.m	P	2 a.m.	P
RR, per minute	15±0,6	15±0,74	0	15±0,64	0	10±0,79	<0,01
MVR (in liters/min)	10,5±0,51	11±0,59	<0,05	11±0,71	<0,05	9,2±0,7	<0,05
OC (in ml/min)	250±15,3	259±16,0	0	277±2,09	0	230±15,4	0,1
COU (in ml/liter)	25±2,28	23±2,68	0,2	25±2,77	0	26±2,93	0,3
VCL (in liters)	3,1±0,01	3,1±0,01	0	3,1±0,01	0	3,1±0,02	0
Tiffeneau's test (in %)	59±2,8	79±2,2	<0,05	65±2,2	0,2	62±0,25	0,1
MVL (in liters/min)	68±5,07	65±3,8	0,2	66±3,7	0,3	62±4,46	<0,05
Respiratory reserve (in liters/min)	6,8±0,74	5,9±0,59	<0,05	5,9±0,05	<0,05	7,2±0,92	0,2
RAM (in liters/min/liter)	22±1,11	21±1,22	0,2	21±1,3	0,2	19±1,04	<0,01
Power of: inspiration (in liters/sec)	3,5±0,2	3,7±0,24	0,1	3,5±0,15	0	3,4±0,15	0,2
expiration (in liters/sec)	3,3±0,22	3,5±0,24	<0,05	3,1±0,17	0,1	3,2±0,18	0,2

on all these subjects ruled out the presence of diseases of the internal organs. The data were subjected to statistical analysis by variance and difference methods. The parameters of ERF at noon, 9 p.m., and 2 a.m. were compared with their corresponding values at 7 a.m. Differences were regarded as significant for which $P < 0.05$.

RESULTS

The results of the study of the diurnal rhythm of variations in the ERF parameters in clinically healthy subjects aged from 20 to 50 years are given in Table 1. They show that RR at 7 a.m. under basal metabolic conditions averaged $15.9 \pm 0.45/\text{min}$. No statistically significant difference was found between the value of RR at 7 a.m. and at other times during the 24 h. Under basal metabolic conditions the mean value of MVR was 13.2 ± 0.53 liters/min. At night there was a statistically significant decrease in MVR compared with its value at 7 a.m. ($P < 0.05$). At midday and in the evening no significant changes were recorded in MVR. OC per minute at midday and during the evening and night likewise showed no statistically significant variation. The coefficient of oxygen utilization (COU) was slightly increased at noon, 9 p.m., and 2 a.m.; however, these differences were not statistically significant. No significant changes were found in VCL. Under basal metabolic conditions MVL was 78.8 ± 3.53 liters/min. During the evening and night a small decrease, not statistically significant, was observed in MVL. Variations in the respiratory reserve during the 24 hours were not statistically significant. Changes in RAM (the ratio between MVL and VCL) during the 24 h likewise were not significant. The power of inspiration at 7 a.m. was 4.2 ± 0.164 liters/sec. By 9 p.m. an increase to 4.6 ± 0.76 liters/sec was observed (statistically significant, $P < 0.05$). At noon and at night this parameter did not differ significantly from its level at 7 a.m. The power of expiration at 7 a.m. was 3.7 ± 0.20 liters/sec. No significant variations in the value of this parameter were observed during the 24 h.

Analysis of the results of the investigation of the diurnal rhythm of fluctuations in the ERF parameters in healthy persons aged 50-62 years showed a regular diurnal rhythm that differed somewhat from that in the healthy subjects of the younger and middle-aged groups (Table 2).

The results in Table 2 show a statistically significant decrease in RR at 2 a.m., an increase in MVR in the afternoon and evening and a decrease at night, an increase in the results of Tiffeneau's test at noon,

a decrease in MVL at night, a decrease in the respiratory reserve at noon and in the evening, a decrease in RAM at night, and an increase in the power of expiration at noon.

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