EXPERIMENTAL BIOLOGY

SEASONAL CHANGES IN BLOOD PRESSURE AND SOME PARAMETERS OF CARDIAC CONTRACTILITY IN INTACT RABBITS

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Parameters of cardiovascular functions [2, 3, 8-10], including blood pressure [1], have a well defined seasonal rhythm; seasonal differences in parameters such as cardiomyocyte ultrastructure or peak systolic pressure inside the chambers of the heart may be more marked than changes in these parameters arising in certain pathological processes [6].

The aim of this investigation was a systematic study of changes in blood pressure in the course of the year, on the grounds that this would permit a fundamentally new evaluation of the time course of blood pressure in patients with essential hypertension, and of methods of pharmacotherapy of this disease.

EXPERIMENTAL METHOD

Experiments were carried out on 28 mature male chinchilla rabbits weighing 2.5-3.5 kg. Under local anesthesia, the systolic (BP_{max}) and diastolic (BP_{min}) blood pressure was recorded by means of an electromanometer in the left common carotid artery. Next, under superficial hexobarbital anesthesia thoracotomy was performed in the third left intercostal space, the left and right ventricles were cannulated, and the peak systolic pressure in the left (IVP_r l.v. — real intraventricular pressure) and right (IVP_r r.v.) ventricles were recorded on tape by a "Mingograf-82" polygraph. Next, the aorta (for the left ventricle) and the pulmonary artery (for the right ventricle) were occluded for 5 sec and the peak systolic (maximal) intraventricular pressure was recorded under conditions of virtually isometric contraction of the ventricles (IVP_m l.v. and IVP_m r.v.). The numerical results were subjected to statistical and correlation analysis on an IBM PC/AT personal computer, using our own program. Differences between the means were regarded as significant at the $p < 0.05$ level ($T < 2$). Correlation was assessed as strong for an absolute value of the coefficient of correlation $\rho \geq 0.70$, of average strength at $\rho = 0.69$-0.30, and as weak at $\rho \leq 0.29$. The statistical program introduced into the computer enabled the level of significance of correlation to be determined depending on the number of observations, the value of coefficient of correlation, and the character of the correlation curve.

EXPERIMENTAL RESULTS

The seasonal rhythm of the parameters studied is shown in Table 1.

The results given in Table 1 show that BP_{max} and BP_{min} have a distinct seasonal rhythm, reaching maximal values in winter and minimal in summer (the difference between the means is significant). In spring and the fall, intermediate values of the parameters are found. In summer all parameters of contractility of the two ventricles reach minimal values, and highest values for the function of both ventricles are attained in winter.

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TABLE 1. Seasonal Rhythm of Arterial Pressure and some Parameters of Cardiac Contractility in Intact Rabbits (M ± m)

Parameter, mm Hg	Season			
	spring	summer	fall	winter
BP_{max}	149±6,70	123±3,70	139±5,00	174±6,90
BP_{min}	115±5,30	98±3,40	107±3,40	124±4,60
IVP_r l.v.	91±5,60	68±4,00	104±6,30	101±3,80
IVP_m l.v.	158±6,50	134±7,50	185±7,20	217±10,0
IVP_r r.v.	24±0,83	7,4±0,78	21±0,80	23,7±0,45
IVP_m r.v.	38±1,90	16,4±2,10	39,6±2,50	49,3±1,70

Legend. Within each group of parameters, those differing significantly from all the rest are underlined.

TABLE 2. Seasonal Rhythm of Correlation between some Parameters of Cardiovascular Function in Intact Rabbits

Pairs of parameters	Season			
	spring	summer	fall	winter
BP_{max} – BP_{min}	±0,97	+0,73	+0,93	+0,98
IVP_r l.v. – BP_{min}	±0,96	±0,91	±0,96	±0,88
IVP_r l.v. – IVP_m l.v.	±0,99	±0,88	±1,00	±0,86
IVP_r l.v. – IVP_r r.v.	±0,96	+0,72	±0,99	±0,91
IVP_r l.v. – IVP_m r.v.	±0,87	+0,84	±0,98	+0,76
IVP_r r.v. – IVP_m r.v.	+0,73	±0,94	±0,90	±0,89
IVP_r r.v. – IVP_m l.v.	+0,73	±0,90	±0,79	±0,87
IVP_m r.v. – IVP_m l.v.	±0,91	±0,98	±0,89	±0,99
Average strength of correlations	0,89± 0,04	0,86± 0,04	0,93± 0,03	0,89± 0,03

Legend. Significant values of ρ are underlined.

The presence or absence of correlation between the parameters studied is shown by the results of correlation analysis in Table 2.

The data in Table 2 confirm the view expressed previously [7] that under normal conditions strong positive correlation exists between parameters of cardiac contractility such as the real and maximal attainable peak systolic pressure in the ventricles, taken in all possible combinations, indicating a high degree of synchronization of the function of the contractile elements of the heart muscle. As the results of this investigation show, strong and significant positive correlations exist between parameters such as BP_{max} and BP_{min} and BP_{min} and IVP_r of the left ventricle. It must also be pointed out that in all seasons the strength of these correlations remains virtually constant (see the last column in Table 2, which gives averaged values of absolute coefficients of correlation). However, depending on the number of significant correlations the seasons can be arranged in the following diminishing order: fall–winter–spring–summer.

The results show that in winter the cardiovascular system works with definite overstrain (the maximal values of most parameters), whereas in summer it is in the quietest state (minimal values of all parameters). The fact that the smallest number of significant correlations between the parameters studied is found in summer is evidence of weakening of their rigid interdependence and, consequently, of the higher ability of the cardiovascular system to adapt itself to both physiological and extremal stimuli.

So far as seasonal differences between values of parameters characterizing cardiovascular function are concerned, these changes can be explained from the standpoint of the pioneers of the concept of alternating activity of elements of every biological system [4, 5]. More functional elements are active at one time of the year and fewer are "resting" than at other times, possibly due to differences in levels of hormonal activity and vitamin balance.

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