DURATION OF PHASES OF THE CARDIAC CYCLE IN RABBITS

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Results of analysis of the phase structure of systole in rabbits (based on polycradiographic data) are described. A close rectilinear relationship was demonstrated between the durations of electrical, mechanical, and total systole; and also of the expulsion period on the one hand and duration of the cardiac cycle on the other. Formulas were deduced to express this relationship quantitatively.

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Rabbits are used extensively in experimental research. Data for the rhythm and structure of the cardiac cycle of these animals are given in the literature [1, 2, 7, 9, 10, 12].

In this paper we give data for the duration of phases of the cardiac cycle based on analysis of 309 polycardiograms (PCG, Fig. 1) of 112 rabbits (chinchilla breed) aged 9-18 months (60 males, 52 females) and weighing 2.1-3.7 kg. The PCG for each rabbit was recorded 2-4 times with intervals between investigations ranging from a few days to a few months.

The right common carotid artery of all the rabbits was exteriorized into a skin flap with blood supply at the age of 6-8 months. The PCG was recorded with the animal in the supine position 3-6 min after fixation.

The ECG was recorded in standard lead II by flat surface electrodes, and the phonocardiogram and sphygmogram of the common carotid artery were recorded by a method described previously [6, 8].

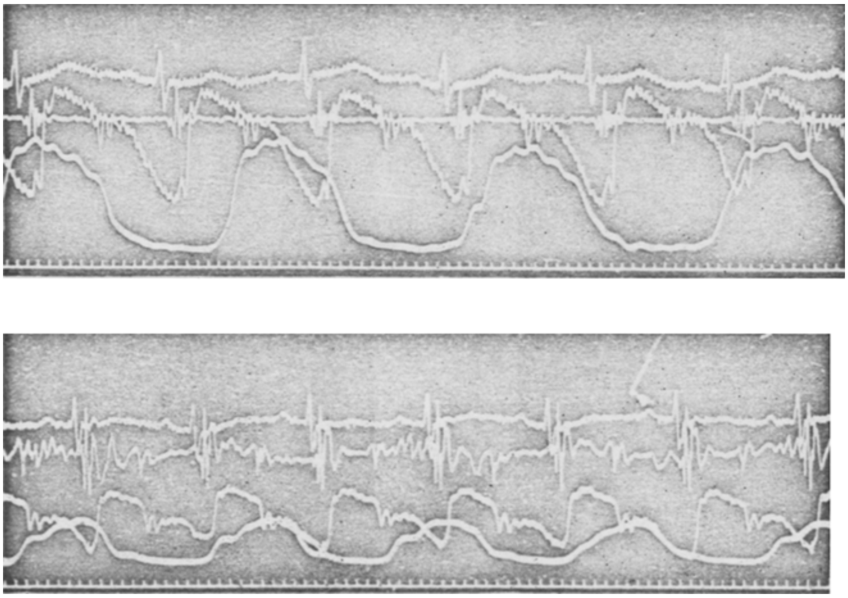

Fig. 1. Polycardiogram of a rabbit. From top to bottom: ECG, standard lead II, phonocardiogram (from the chest), sphygmogram of the common carotid artery, pneumogram, time marker 0.02 sec.

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TABLE 1. Duration (in msec) of Phases of Cardiac Cycle and Values of Indices

Phase of cardiac cycle and indices	M ± m	Standard deviation (±σ)	Limits of variations	Variance ratio (in %)
Number of contradictions/min	260±1.8	±30	190–354	11.4
Cardiac cycle	231±2.0	±26	170–315	11.3
Systole:				
electrical	132±1.0	±17	90–184	13.0
total	134±1.0	±15	94–190	11.2
mechanical	107±1.0	±15	66–158	14.0
Asynchronous contraction	26±0.1	±2	18–40	7.7
Isometric contraction	15±1.0	±10	0–36	66.6
Period of contraction	41±1.0	±10	20–70	24.4
Period of expulsion	92±1.0	±15	50–125	16.3
Diastole:				
electrical	99±1.0	±18	–	18.0
mechanical	124±1.0	±16	–	13.0
Systolic index:				
from ECG	0.57±0.005	±0.07	0.42–0.81	12.3
from PCG	0.46±0.004	±0.066	0.32–0.61	13.0
Intrasystolic index	0.859±0.004	±0.077	0.489–0.968	7.7
Intrasystolic coefficient	2.244±0.040	±0.630	1.22–6.18	28.2
Index of myocardial contraction (after V. L. Karpman [5])	0.305±0.004	±0.061	0.137–0.623	20.0
Hemodynamic index (after I. N. Bronovets [2])	0.163±0.005	±0.074	0–0.318	45.4

TABLE 2. Correlation between Duration of Phases of Systole and of Cardiac Cycle

Elements of cardiac contraction	Correlation ratio $\eta \pm m_\eta$	Coefficient of correlation $r \pm m_r$	Coefficient of regression $R \pm m_R$
Phase of asynchronous contraction	0.13 ± 0.06	0.06 ± 0.06	–
Phase of isometric contraction	0.22 ± 0.06	0.06 ± 0.06	–
Period of contraction	0.39 ± 0.05	0.13 ± 0.06	–
Systole:			
electrical	0.60 ± 0.04	0.62 ± 0.04	0.406 ± 0.016
mechanical	0.76 ± 0.03	0.81 ± 0.02	0.467 ± 0.009
total	0.67 ± 0.03	0.67 ± 0.03	0.386 ± 0.023
Period of expulsion	0.73 ± 0.03	0.76 ± 0.03	0.438 ± 0.013

The PCG was analyzed after fivefold linear magnification. The duration of the following intervals was measured: R–R, the cardiac cycle; Q–T, electrical systole; Q–1st sound, phase of asynchronous contraction; Q–2nd sound, total systole; 1st-2nd sound, mechanical systole, c–e, period of expulsion. Values of the remaining indices were obtained by appropriate calculation (Table 1).

To determine the existence and character of the relationship between durations of individual elements of contraction and the duration of the cardiac cycle as a whole, the following indices were calculated:

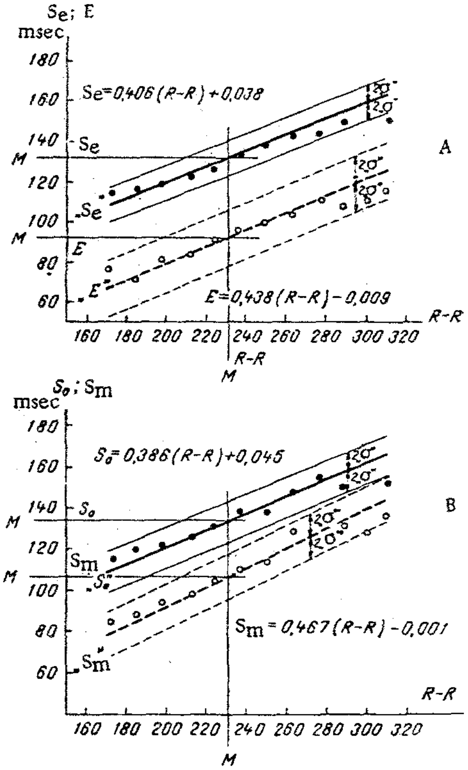

Fig. 2. Lines of regression with 65% confidence interval, equal to twice the deviation of the regression equation. Dots and triangles represent averaged experimental values of contraction phases in corresponding intervals of R−R values. A) for electrical systole (S_e) and period of expulsion (E); B) for total systole (S_t) and mechanical systole (S_m) relative to duration of cardiac cycle R−R. Values of R−R and free term in regression equations given in seconds. Standard deviations for $S_e/R\text{-}R = \pm 0.004$; $S_t/R\text{-}R = \pm 0.005$; $S_m/R\text{-}R = \pm 0.006$; $E/R\text{-}R = 0.007$.

the correlation ratio η and the coefficient of correlation σ between values of the corresponding time characteristics [4, 11].

The results given in Table 2 show that a close rectilinear relationship exists between the durations of electrical, total, and mechanical systole and the period of expulsion, on the one hand, and the duration of the cardiac cycle on the other. The same table also shows that no significant relationship exists between durations of the phases of asynchronous and isometric contraction or the duration of the total period of contraction, and the duration of the complete cardiac cycle.

The coefficient of regression R was calculated for elements of cardiac contractions showing close rectilinear correlation with the durations of the cardiac cycle (Table 2), and equations of rectilinear regression of the general type $y = a + bx$ were solved. In this way special formulas were obtained expressing the quantitative relationship between durations of these elements and total duration of the cardiac cycle. Regression lines plotted on the basis of these formulas (Fig. 2, A and B) can be used as nomograms for determining the required values of total, electrical, and mechanical systole and also of the expulsion period for a known duration of the cardiac cycle.

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