The possibility of using the atrial myocardium to control artificial ventricles is examined. Correlation was studied between the tension of the atrial wall and the tension and pressure in the ventricles during random variation of the cardiac rhythm was studied. Tension in the wall of the corresponding part of the heart was recorded by means of arch strain gauges and the intraventricular pressure by means of an electromanometer during catheterization of the chambers of the ventricles. The cardiac rhythm varied from 2.0 to 4.0 sec⁻¹. Correlation was demonstrated in the atria between the tension and interspike interval (coefficient of correlation 0.62 ± 0.05). Close correlation was detected between tension in the atrial wall and the intraventricular pressure. The coefficient of correlation in this case varied from 0.713 ± 0.09 to 0.874 ± 0.02 depending on the mean duration of the interspike interval. Information on atrial contractions can be used to control an artificial heart.

**KEY WORDS:** control of the artificial heart; cardiac rhythm; isometric atrial contraction; intraventricular pressure; rhythmic-ionotropic correlation.

An important problem during the creation of an artificial heart is that of its control. Adequate control of the cardiac frequency is its principal aspect. Generally, it is necessary to regulate not only the heart rate but also the cardiac output, the rate of rise of pressure, and other parameters of mechanical activity of the artificial heart. It is natural to use the surviving atria, which preserve their innervation and their sensitivity to humoral agents [5] to control the artificial ventricles. For this purpose various types of mechanical tension or deformation formed in the atrium, on the basis of which the control system carries out regulation of the activity of the artificial ventricle, can be used for this purpose. Such a system must have definite advantages over control systems based on the original information of the state of the internal milieu (pO₂, pCO₂, pH, etc.), for closer correlations are used between activity of the atria and ventricles.

To put this proposed approach into effect, the first step must be to ensure that correlation exists between the contractile activity of the atria and ventricles during normal functioning of the heart, at different values of the heart rate or in the presence of a randomly varying rhythm. Preference was awarded to the "random regime" for it corresponds to a greater degree to the natural conditions of function [1, 2].

**EXPERIMENTAL METHOD**

Experiments were carried out on mongrel dogs of both sexes weighing 5–8 g on which thoracotomy had been performed under thiopental anesthesia and the heart, free from pericardium, was exteriorized into the wound. Tension in the wall of the atria and ventricles was recorded by means of arch strain gauges, sutured to the corresponding regions. The rigidity of construction was 20 g/mm, ensuring a sufficiently close approximation to isometric conditions. The intraventricular pressure was recorded by an electromanometric system.

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TABLE 1. Mean Values of Coefficients of Correlation ($\bar{R}$) and Dispersion ($\eta$) Functions (with errors of means) of "Interspike Interval-Tension" and Characteristics of Nonlinearity $n$ and $y$ at Different Mean Values of Interspike Intervals ($T$) in Left (A) and Right (B) Hemispheres

<table>
<thead>
<tr>
<th>$T$, msec</th>
<th>$\bar{R}$</th>
<th>$\eta$</th>
<th>$n$</th>
<th>$y$</th>
<th>$\bar{R}$</th>
<th>$\eta$</th>
<th>$n$</th>
<th>$y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>350±20</td>
<td>0.113±0.05</td>
<td>0.239±0.04</td>
<td>0.21</td>
<td>0.16</td>
<td>0.260±0.02</td>
<td>0.301±0.06</td>
<td>0.23</td>
<td>0.25</td>
</tr>
<tr>
<td>270±15</td>
<td>0.260±0.02</td>
<td>0.608±0.04</td>
<td>0.10</td>
<td>0.25</td>
<td>0.266±0.01</td>
<td>0.37±0.01</td>
<td>0.21</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Fig. 1. Average correlation function between interspike interval and tension in left ventricle (A) and left atrium (B). Ordinate, coefficient of correlation ($\bar{R}$); abscissa, No. of shift ($\tau$). Crosses indicate mean interspike interval 350 msec; circles indicate mean interspike interval of 270 msec.

for cardiac catheterization. Electrical stimulation was applied in the form of square pulses (5 V, 5 msec). The electrodes were located on the right ventricle. A specially designed stimulator, providing both a constant rhythm and a random sequence of pulses (a gaussian stochastic process with autocorrelation coefficient at the first shift of not more than 0.07) with coefficient of variation (var T) regulatable between 4 and 22%. The frequency range used was 2.0, 3.0, and 4.0 sec$^{-1}$. After the first processing the experimental results were calculated on the BESM-4 computer. The mean values, dispersion, coefficient of variation, and cross-correlation functions between series were calculated. To determine the class of the system and the possibility of using correlation analysis in order to study the relationship between the variables, a test for nonlinearity was used [3]. This test was carried out by means of dispersion functions, which are characteristics of correlation between processes in the case of nonlinear functions [6]. The value of correlation ($\bar{R}$) and dispersion ($\eta$) functions coincide only in the case of a stochastic process of linear structures [4]. The value of $\eta$ was calculated by the equations:

$$\eta_{xy}(\tau) = \sqrt{\frac{\theta_{xy}(\tau)}{D(y)}}.$$