ASSESSMENT OF THE CIRCULATORY SYSTEM IN DOGS WITH TRANSPLANTED HEARTS

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The state of the animal's own heart and of the transplanted heart was assessed in dogs by the method of variance pulsometry (plotting variance curves from values of a dynamic series of RR intervals of the ECG).

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The problem of organ transplantation is very complex. Besides the solution of problems connected with operative technique and biological compatibility, the ensuring of normal function of the transplanted organ likewise is most important. The development of methods for assessing the function of such organs is therefore of considerable scientific interest.

A method of evaluation the circulatory function in dogs with a transplanted heart is described in this paper.

EXPERIMENTAL METHOD

To assess regulatory influences on cardiac activity R. M. Baevskii's method of variance pulsometry was used. This is based on the construction of variance curves from values of a dynamic series of RR intervals on the ECG.

When plotting variance curves, values of the RR intervals in seconds are plotted along the abscissa and the number of intervals in each group. Grouping of the values is done every 0.05 sec. The variance curve is characterized by its position on the abscissa (in the center, on the left or right) and its width (narrowing, widening).

Predominance of sympathetic tone is indicated by a shift of the variance curve into the region of values on the extreme left (shortening of the RR intervals) and a decrease in its width, while the pattern is reversed for predominance of parasympathetic tone.

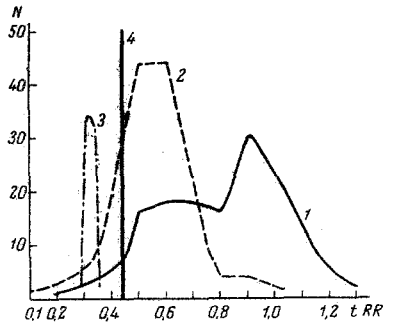

Fig. 1. Variance curves of RR interval of ECG of dog's own heart before operation (1), after anesthesia (2), at end of operation (3), and of transplanted heart at end of operation (4).

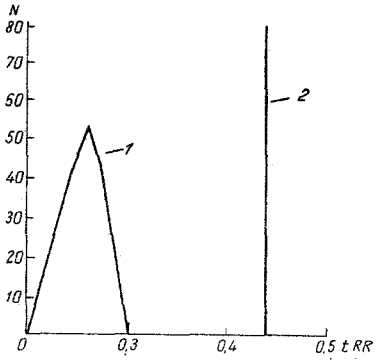

Fig. 2. Variance curves of RR interval of ECG of dog's own heart (1) and transplanted heart (2) on 3rd day after transplantation.

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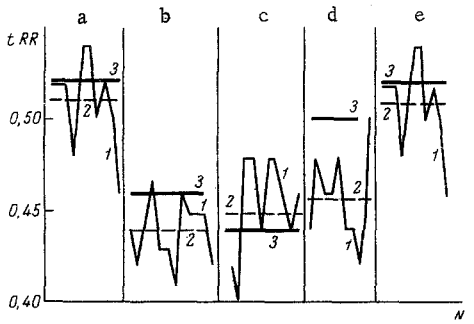

Fig. 3. Variance curves of RR interval of ECG for a dog with a transplanted heart at various times after measured physical exertion test: a) before test: b-d) 1, 2, and 3 min after test; e) 5 min after test; 1) RR intervals of dog's own heart; 2) mean value of RR interval during 1 min; 3) RR intervals of transplanted heart.

The application of variance pulsometry to assessment of the function of the transplanted heart is made difficult because usually the potentials of both hearts are recorded simultaneously on the ECG, and for that reason special chest leads were developed to enable the potentials to be recorded mainly from one heart. The ECG of the dogs was recorded before the operation (in the free state and under general anesthesia), during the operation, immediately after heart transplantation, and on the 2nd and 3rd days after the operation.

EXPERIMENTAL RESULTS

Variance curves plotted from the results obtained in one of the experiments are shown in Fig. 1. Anesthesia and the operative procedure were accompanied by an increase in sympathetic tone (stress). The transplanted heart, unconnected with nervous centers, was subjected to humoral influences only. It worked at a uniform rate without respiratory variations. The mean rate of contractions of the transplanted heart was usually a little below that of the animal's own heart This is clearly seen in the variance curve, represented by a straight line (all values of the RR intervals of the transplanted heart differ from each other by an amount not exceeding 0.01-0.02 sec).

Variance cures for the same dog on the 3rd day after transplantation are shown in Fig. 2. The dog's own heart contracted at a frequency corresponding to an RR interval of 0.2-0.3 sec. A sharp shift of the variance curve to the left denotes predominance of sympathetic influences. The transplanted heart contracted at the same rate as before. It is important to note that whereas the variance pulsogram of the dog's own heart on the 3rd day after the operation was slightly shifted to the left and widened, the variance pulsogram of the transplanted heart remained in practically the same position along the abscissa.

The rhythm of the transplanted heart was transformed more slowly than that of the dog's own heart, because all "orders" from the central nervous system were transmitted to it humorally. This is illustrated by the results of an experiment in which a dog with a transplanted heart was subjected to a graded physical exertion test. Segments of variance curves of the RR interval of the dog's ECG before and at various periods after the test are shown in Fig. 3.

It is clear from Fig. 3 that the rhythm of the transplanted heart increased more slowly and reached its maximum later than the rhythm of the dog's own heart. The rhythm of the transplanted heart likewise returned to its intial value faster.

The method developed by the authors for assessing circulatory function in dogs with a transplanted heart can thus be used to evaluate different aspects of cardiac activity: with the aid of electrocardiography and sphygmography it can be used to assess the automatism of excitability, conductivity, and contractility; the neurohumoral regulation of the heart can be assessed on the basis of variance pulsometry.