The accuracy of the suggested method is shown by data on the base composition of DNA and the content of pyrimidine nucleotides of different lengths (Tables 2 and 3), determined by scanning of thin-layer plates and, for comparison, by spectrophotometry of eluates.

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USE OF BALLOON CATHETERS TO MONITOR MYOCARDIAL RESTING TENSION DURING OPERATIONS WITH CARDIOPLEGIA

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Cardioplegia at the present time is the most promising method of protecting the heart against ischemic damage during operations. Meanwhile cardioplegia has not only a protective action, but also a harmful action [1-6]. Possible corrections can be introduced into the course of cardioplegia, the method itself significantly improved allowing for individual differences between hearts, and indications for additional infusions of solution during operation can be objectively determined, however, only if dynamic monitoring of the functional state of the arrested heart is carried out during the operation.

One such technique has been developed in the writers' Institute and has successfully undergone clinical trials [3].

However, this method did not permit a quantitative assessment of changes taking place, and the measuring apparatus required for that purpose was very clumsy and complicated.

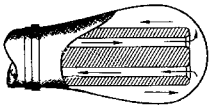

Fig. 1. Scheme of modification of twin-lumen catheter to record myocardial resting tension.

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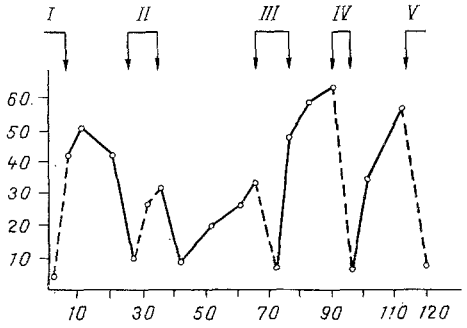

Fig. 2

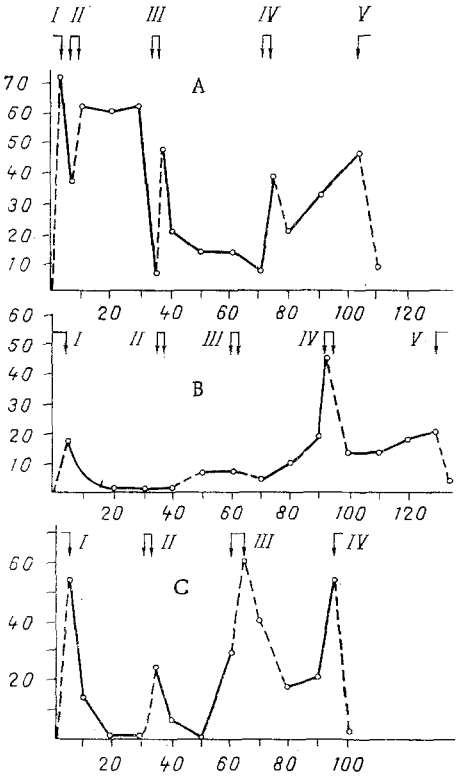

Fig. 3

Fig. 2. Time course of myocardial tension recorded by strain gauge method (patient N., aged 45 years). Abscissa, time (in min); ordinate, resting tension (in conventional units). Broken line indicates response of myocardium to injection of cardioplegic solution: I-IV) periods of reperfusion of cardioplegic solution, V) reoxygenation of heart after removal of clamp from aorta.

Fig. 3. Time course of myocardial resting tension recorded by balloon method. A) Patient I., B) patient B., C) patient S., undergoing operations under cardioplegia. A, IV) Reoxygenation of the heart after removal of clamp from aorta. Remainder of legend as to Fig. 1.

It was accordingly decided to attempt to simplify the design of the resting tension transducers as much as possible, to increase their sensitivity, and to widen the range of applications of the method, by using standard apparatus of modern operating theaters for this purpose.

The investigation was conducted on 22 patients undergoing operations under cardioplegia induced by injection of balanced ionic solution into the blood stream [1]. The method of recording myocardial resting tension was based on the familiar principle of measurement of intramyocardial pressure. For this purpose, the inflatable balloon of a standard Swan Ganz (USA) twin-lumen catheter was connected to the second lumen (Fig. 1) and the surface area of the balloon adjusted to 1 cm^2. The balloon was filled with sterile physiological saline or dioxidine solution. It was then introduced into the wall of the working left ventricle near the apex, to a depth of 6-8 mm and fixed with a purse-string suture. The balloon was inflated a little. The other end of the catheter was connected to a standard "Galileo" (Italy) calibrated venous pressure transducer, a pressure unit (Galileo), and recorder. The value obtained was estimated in mm Hg/cm^2 and in g/cm^2. The transducer was removed 5-10 min after restoration of cardiac activity.

The results were compared with those of recording myocardial tension by means of strain gauge transducers (11 patients), devised by Shumakov et al. [3].

A typical trace of myocardial tension obtained by the strain gauge method is shown in Fig. 2. A series of traces of myocardial resting tension recorded by the balloon described above, introduced into the wall of the left ventricle, is demonstrated in Fig. 3.

TABLE 1. First Derivative of Intramyocardial Pressure (IMP) during Contraction and Relaxation of Heart before and after Cardioplegia

Parameter	Initial value	First contraction	5 min after restoration of cardiac activity
first derivative of IMP during contraction	146,0±9,4	144,0±8,2	141,3±11,0
first derivative of IMP during relaxation	115,6±8,2	130,7±8,4	129,2±5,2

These results and the kinetics of their change during the operation demonstrate the complete identity of traces reflecting processes taking place in the myocardium. For instance, the first injection of cardioplegic solution was accompanied by primary contraction of the myocardium followed by relaxation, in full agreement with the experimental and clinical data described in the literature [1-3]. During repeated infusions of cardioplegic solution, just as when recorded by the strain gauge method, two types of responses were observed. If reperfusion coincided with the isotonic plateau stage, it was accompanied by a second response of the myocardium: contraction and relaxation. If, however, reperfusion was carried out at the stage of rising myocardial tension, it induced a favorable response, namely relaxation of the heart.

Incidentally, the balloon method enables myocardial contractility to be assessed additionally before and after cardioplegia, and yields significant additional information allowing choice of tactics for management of the patient during the recovery period. As an illustration, the first derivatives of contraction and relaxation of the heart (in g/sec/cm^2) are given in Table 1.

The use of balloon catheters for monitoring the myocardial resting tension during operation thus allows the functional state of the heart to be kept under observation in the course of the operation, the time of giving additional infusions of the cardioplegic solution to be determined, and myocardial contractility to be evaluated before and after cardioplegia.

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