THE INFLUENCE OF SELECTED LEFT VENTRICULAR AND SYSTEMIC PARAMETERS ON CARDIOVASCULAR HEMODYNAMICS AND ENERGETICS - MODELLING STUDY

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Abstract

Ventricular sufficiency can be estimated basing on the heart muscle's ability to effective ejection in systole and filling conditions created in diastole. These features, in quantitative sense, can be evaluated by selected energetic and hemodynamic parameters of the ventricle and the circulatory system.

In the computer model and the physical model of blood circulation, pathological states of the left ventricle and the systemic arterial tree, represented by ventricular compliance, the filling characteristic and peripheral resistance have been simulated. The influence of the modelled pathological states on hemodynamics and energetics of the circulatory system has been discussed. In some cases, left ventricular assistance using an LVAD has been applied.

The computer model CARDIOSIM and the physical model MCS, with computer-controlled ventricles and peripheral resistances, were developed at the Institute of Biomedical Technologies CNR in Rome (Italy). In these models, the energetic relations among the ventricle, the arterial system and the assist device are analysed on the pressure-volume plane (P-V).

The LVAD was developed at the Institute of Biocybernetics and Biomedical Engineering PAS. It consists of the following units: the artificial left ventricle ALV, the pneumatic drive unit PDU and the electronic control system ECS. In the device, the driving positive and negative pressure signals for the systole and diastole phases are realised by means of one pneumatic element in the PDU of special original design.

The following parameters were used to estimate condition of the circulatory system in different pathological states, including left ventricular assistance: left atrial pressure p_{LA}, aortic pressure P_{as}, arterial pulmonary pressure P_{ap}, cardiac output CO, cardiac output index CI, external work EW, oxygen consumption V_{O2} and cardiac mechanical efficiency CME.

Keywords: ventricular compliance, peripheral resistance, hemodynamics, ventricular energetics, external work, oxygen consumption, heart assistance