# EFFECT OF ARTIFICIAL CIRCULATION ON THE FRACTIONAL COMPOSITION OF HEART AND SKELETAL MUSCLE PROTEINS

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Regional perfusion produces no changes in the protein fractions of skeletal and heart muscles, but an extracorporeal circulation is associated with some increase in the fraction of sarcoplasmic proteins in heart muscle and a decrease in fraction T, the fraction of "readily soluble" myofibrillary proteins.

No complete investigation of the protein composition of cardiac and skeletal muscles during the prolonged action of an artificial circulation has yet been described in the literature.

In the work described below, all principal fractions of muscle proteins were studied during an artificial circulation.

## EXPERIMENTAL METHOD

In the experiments of series I the composition of skeletal muscle proteins fractions was studied in rabbits during regional perfusion of the hind limb. The Ballyuzek–Farshatov method of regional perfusion [2] and oxygenated donor's blood were used. An experimental heart-lung apparatus constructed by the Leningrad Branch of the All-Union Research Institute of Medical Instrumentation was used as the oxygenator-pump; the rate of perfusion was 25 ml/min and its duration 2 h.

In the experiments of series II, protein fractions of the heart muscle were determined after regional perfusion of the head and heart of a recipient dog, with exclusion of the posterior part of the body from the circulatory system (the donor's circulation method).

In the experiments of series III the effect of an extracorporeal circulation on the composition of protein fractions of heart muscle was studied. The extracorporeal circulation was set up in the usual manner on dogs with the ISL-2 apparatus. The volume velocity of perfusion was kept at a constant level (100 ml/kg · min). The experiments on dogs were carried out at the Department of Operative Surgery and Topographic Anatomy, S. M. Kirov Military Medical Academy. In the experiments of series II and III, the mean duration of perfusion was 2 h.

The composition of the protein fractions was determined by the method of Ivanov et al. [3, 4], and the nitrogen content of each separate fraction was determined quantitatively per gram dry tissue. Skeletal muscles for fractionation were excised from the femoral group of muscles of the perfused limb, the symmetrical muscle of the rabbit's unperfused limb acting as control. The composition of the protein fractions in the experiments of series II and III was determined in the papillary muscle and the outer layer of the left ventricle, parts of the myocardium characterized by different intensities of metabolism. Corresponding areas of myocardium from healthy dogs were used as control.

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TABLE 1. Composition of Protein Fractions from Different Parts of Dog's Left Ventricle under Normal Conditions and during Adequate Extracorporeal Circulation (in mg nitrogen/g dry tissue)

| Fraction | Outer layer of left ventricle | | | Papillary muscle of left ventricle | | |
|---|---|---|---|---|---|---|
| | control | experiment | P | control | experiment | P |
| Total nitrogen | 125.3±2.7 | 133.1±5.7 | > 0.05 | 122.3±3.8 | 134.7±5.7 | > 0.05 |
| Nonprotein nitrogen | 9.8±0.4 | 9.8±0.4 | > 0.05 | 10.6±0.3 | 9.6±1.0 | > 0.05 |
| Protein nitrogen | 115.4±2.8 | 123.3±6.0 | > 0.05 | 117.1±2.7 | 125.1±6.7 | > 0.05 |
| Nitrogen of sarcoplasmic proteins | 35.4±1.1 | 43.5±2.6 | < 0.05 | 34.3±0.9 | 44.1±2.6 | < 0.05 |
| Nitrogen of myofibrillary proteins | 43.6±0.9 | 40.4±1.6 | > 0.05 | 42.5±1.1 | 40.6±1.3 | > 0.05 |
| Nitrogen of proteins of actomyosin complex | 28.7±0.5 | 28.4±1.2 | > 0.05 | 28.4±0.7 | 28.0±1.2 | > 0.05 |
| Nitrogen of proteins of fraction T | 14.4±0.4 | 11.6±0.7 | < 0.05 | 13.8±0.3 | 12.1±0.4 | < 0.05 |
| Nitrogen of stromal proteins | 35.1±1.1 | 39.1±2.2 | > 0.05 | 33.4±1.3 | 39.7±3.0 | > 0.05 |
| Total nitrogen of all fractions | 123.9 | 132.8 | | 120.8 | 134.0 | |

## EXPERIMENTAL RESULTS

During regional perfusion of the limb under adequate conditons for 2 h, no significant changes were found in the total protein content in the skeletal muscle of the rabbit, or in the content of myofibrillary, sarcoplasmic, and stromal proteins. Only a slight change in nonprotein nitrogen was observed, its content increasing in the perfused muscle (18.5±0.7) compared with the control (16.2±0.6).

Regional perfusion of the head and heart of a recipient dog with blood from a donor's dog by the crossed circulation method likewise caused no statistically significant changes in the nitrogen content of individual protein fractions or of total protein, or in the total nitrogen content of all investigated areas of the myocardium of the experimental animal (papillary muscle, outer layer of the left ventricle). The exception was the nonprotein nitrogen fractions of the dog's left ventricle which, as in the previous case, was slightly increased (11.2±0.3, compared with the normal 9.8±0.4). This probably indicates some intensification of protein breakdown, although the total protein content was not substantially different from that in the control.

A prolonged extracorporeal circulation had the most definite effect on the composition of protein fractions of heart muscle. Despite maintenance of adequate conditions, perfusion of the animal for 2 h led to changes in the content of sarcoplasmic proteins in different parts of the heart muscle. The content of sarcoplasmic proteins in the outer layer and papillary muscle was higher than in the control (Table 1). The content of the "readily soluble" fraction of myofibrillary proteins was very slightly reduced. The slight changes in the remaining fractions (increase in total nitrogen, protein nitrogen, and nitrogen of stromal proteins) were not statistically significant.

These results suggest that the decrease in content of blood proteins observed by many workers during whole-body perfusion [1, 7, 8] is partially due to deposition of serum proteins in the muscle tissue and internal organs, leading to an increase in the fraction of sarcomplasmic proteins. The very slight decrease in content of fraction T of myofibrillary proteins, which play the role of reserve precursor proteins [5, 6], observed in these experiments during prolonged extracorporeal circulation, may perhaps be connected with changes in protein biosynthesis under unusual conditions of myocardial function (absence of external load, fibrillation, supply of blood whose biochemical constants undergo change during prolonged contact between the blood and apparatus, to the myocardium, and so on).

It can thus be concluded from these investigations that regional perfusion, under adequate conditions, causes no change in the composition of protein fractions of the myocardium and skeletal muscles, whereas prolonged extracorporeal circulation is accompanied by an increase in the fraction of sarcoplasmic proteins, evidently through deposition of blood proteins (albumins) in the muscle tissue.

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