POLARIZATION MICROSCOPY AND ITS APPLICATION IN EXPERIMENTAL AND TRANSLATIONAL DIAGNOSTICS OF HEART ATTACK

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Direct polarization microscopy makes it possible to visualize myofibril sarcomeres due to the ability of A-disks to double ray refraction [1] and to assess the state of the cardiomyocyte contractile apparatus in stained and unstained myocardial slices. It has been established that pathological changes in organs and tissues under conditions of respiratory or cardiac arrest occur differently [2]. Therefore, the aim of this study is to assess myocardial condition in two fundamentally different acute conditions associated with insufficient oxygen supply to the heart.

Comparative analysis of polarized and nonpolarized images was carried out via a Zeiss Axio Imager. A1 (Carl Zeiss, Germany) microscope with and without the polarization system. As a result of the anisotropy phenomenon in the myocardium, an optical property such as birefringence is observed. This allows us to visualize the components of the sarcomere since the disks have heterogeneity and unique optical properties. In our experiment, we used a lambda (phase) plate to improve the quality of the image for the analysis.

We counted the length of whole sarcomeres and A and I disks and then performed statistical analysis of the data using Origin Pro software (OriginLab, USA). Measurement results were assessed after checking the normality of the distribution by nonparametric analysis using ANOVA. On the basis of these data, we conducted correlation and regression analysis with the determination of correlation and determination coefficients, as well as the construction of polynomial models of order 3 with the derivation of the equations of dependence describing the obtained data.

The study of the polarization properties of cardiomyocytes showed that the sarcomere length decreased significantly during respiratory arrest and cardiac arrest on average. We studied polarized and nonpolarized images of unstained cardiac sections as well as sections stained with hematoxylin and eosin, basic fuchsin and Lee staining methods.

The median sarcomere length is 1.86 (1.79; 1.92) μm in normal, 1.77 (1.66; 1.82) μm in respiratory arrest, and 1.55 (1.43; 1.67) μm in cardiac arrest. The size of the I-discs also decreased in the experimental groups. The median isotropic disc length for controls is 0.56 (0.45; 0.65) μm and 0.44 (0.38; 0.57) μm for respiratory arrest, whereas it fell to 0.25 (0.22; 0.26) μm for cardiac arrest. At the same time, A-disks in median values for all groups are not characterized by the presence of significant differences.

The study showed that the degree of correlation between A-disk and I-disk sarcomere parameters strongly decreases during the development of various pathological processes associated with hypoxia. The relationship between disc lengths is significantly lower in the experiment with acute cardiac arrest, which can be characterized as a faster process of myocardial damage compared to acute respiratory arrest, which may be associated with circulatory arrest, rapid blood deoxygenation and pronounced development of myocardial ischemia.

[1]. C. L. Berry, J. van der Walt, R. Wyse, Virchows Arch. A Pathol. Anat. Histol, **390**(2), 205-10 (1981)
[2]. G. Piavchenko, I. Kozlov, V. Dremin, et al, J. Biophotonics **14**(12), e202100216 (2021)