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Abstract. Investigation of 69 samples of the myocardium following acute coronary insufficiency (ACI) was carried out: 69 - after chronic ischemic heart disease and 20 - of the control group was. Operative characteristics of Muller-matrix mapping of optically anisotropic molecular endogenic fluorophors of the myocardium in comparison with the traditional method of ACI verification have been established. The method under investigation showed a good level of the balanced accuracy for the diagnostics of ACI.

Introduction

Postmortem verification of acute coronary insufficiency (ACI) in space of time till 6 hour from its beginning makes up a good few of difficulties for forensic medical experts. So, foreign researches note, that ACI establishment for forensic medical experts is problematic from 33% till 96% of cases [6], that is evidence of the necessity of addition of the existing and working out new identification methods of the mentioned pathological condition.

Integration of the achievements between branches of optics and forensic medicine is perspective in this direction. Since myocardium from the standpoint of optics of biotissues is structurally not similar optically anisotropic medium, possessing properties of absorption of the energy of electro-magnetic radiation, then the most general approaches based on Muller-matrix formalism usage [4.5] are necessary to describe interaction of the polarized light with its complicated system. On the other hand, actinomyosin complex is capable to irrigation by means of autofluorescence [1.2]. Therefore, combination of autofluorescent with Muller-matrix analysis may become the key to the development of the effective method of ACI diagnostics.

Material and methods

Sampling of the material was conducted from 2010 to 2015 years in the lodging of municipal establishment "Regional Bureau of forensic medical examination" under mixed lighting, air temperature 18-22oC and relative humidity 60-75%. In all cases sampling was carried out from different anatomical areas. In all 69 samples of myocardium after ACI and chronic ischemic heart disease (CIHD) and 20 samples of myocardium from the cadavers, died due to violent death with a short agonal period were studied. Blocks of volume 1cm^3, cut on freezing microtome with sections thickness 30±5 mcm were formed. Sections were dried. Dried native sections were delivered to the laboratory of the department of correlative optics and spectroscopy of Chernivtsi National University named after Yu. Fedkovych. Sampling for forensic-histological study, which consisted of staining with hematoxylene, principal fuchsine, picric acid (HPTP) according to the Lie method, was conducted simultaneously.

Experimental measurements were carried out in the standard disposition of stocks-polarimetry, modified for autofluorescence investigations.

Measurement of coordinate distributions of intensity of autofluorescence Iy was conducted in the plane of photosensitive ground of the digital camera, and on the basis of the obtained data file (p x k) of Muller-matrix invariants was calculated, the values of which determined optic activity of myosin molecules $r_{14}$ and crystallization degree of the myocardium. Then totality of their statistical moments of the first-fourth orders was calculated. Sensitivity, specificity and balanced accuracy were calculated according to the standards of the demonstrated medicine [3].

Discussion of the results

Muller-matrix mapping of lazer autofluorescence of the myocardium samples of the groups under study was carried out (fig. 1, fig. 2.)

However, ACI verification on the basis of visual analysis of coordinate distribution $r_{14}$ and histograms of their values gets complicated, therefore calculation of the statistical moments of the 1-4 order of Muller-
Fig. 1. Coordinate distributions \( r_{14} \) and histograms of their values of the myocardium of both groups: 1 - coordinate distributions \( r_{14} \) at CHID; 2 - coordinate distributions \( r_{14} \) at ACI; 3 - histogram of values \( N(r_{14}) \) at CHID; 4 - histogram of values \( N(r_{14}) \) at ACI.

Fig. 2. Coordinate distributions \( r_{41} \) and histograms of their values of the myocardium of both groups: 1 - coordinate distributions \( r_{41} \) at CHID; 2 - coordinate distributions \( r_{41} \) at ACI; 3 - histogram of values \( N(r_{41}) \) at CHID; 4 - histogram of values \( N(r_{41}) \) at ACI.

Matrix invariants \( r_{14} \) and \( r_{41} \) was carried out when using laser fluorescent polarimetry (table 1).

Such ranges of distinctions between groups were determined for the statistical moments \( M_{i=1,2,3,4}(q) \), characterizing distributions \( r_{14}(\lambda_i) \) and \( r_{41}(\lambda_i): \)
- \( r_{14}(\lambda_i), \Delta M_i \leftrightarrow 1.28; \Delta M_i \leftrightarrow 1.57; \Delta M_i \leftrightarrow 1.75; \)
- \( r_{41}(\lambda_i), \Delta M_i \leftrightarrow 1.3; \Delta M_i \leftrightarrow 1.69; \Delta M_i \leftrightarrow 2.08; \Delta M_i \leftrightarrow 2.91 \)

As it is obvious, statistical moments of the highest orders - asymmetry and excess, characterizing distribution \( q=\{r_{14,41}\} \) were found to be the most sensitive to the causes of death following ACI.

The results of studying operative characteristics of the Muller-matrix fluorescent mapping method are cited in table 2.

### Table 1

| Statistical moments | Cause of death |
|---------------------|----------------|
|                     | Control (n=20) | CHID (n=69) | ACI (n=69) |
| \( r_{14}(\lambda_f) \) |                 |             |             |
| Average, \( M_1 \)  | 0.59 ± 0.047    | 0.61 ± 0.052 | 0.54 ± 0.045 |
| Dispersion, \( M_2 \) | 0.1 ± 0.009    | 0.12 ± 0.012 | 0.15 ± 0.013 |
| Asymmetry, \( M_3 \) | 0.12 ± 0.011   | 0.31 ± 0.027 | 0.19 ± 0.014 |
| Excess, \( M_4 \)   | 0.58 ± 0.041   | 0.46 ± 0.036 | 0.29 ± 0.027 |
| \( r_{41}(\lambda_f) \) |                 |             |             |
| Average, \( M_1 \)  | 0.74 ± 0.065    | 0.65 ± 0.058 | 0.71 ± 0.062 |
| Dispersion, \( M_2 \) | 0.29 ± 0.024   | 0.26 ± 0.023 | 0.14 ± 0.011 |
| Asymmetry, \( M_3 \) | 1.01 ± 0.085   | 0.78 ± 0.065 | 1.23 ± 0.11  |
| Excess, \( M_4 \)   | 0.96 ± 0.088   | 0.68 ± 0.051 | 1.21 ± 0.11  |

According to the criteria of the demonstrative medicine the balanced accuracy in order to use interval value of Muller-matrix invariant for ACI \( r_{14} \) diagnostics was \( Ac=70%-78\% \), but \( r_{41} Ac=86%-89\% \).
Table 1

| $M_i$ | $r_{14}(\lambda_{14})$ | $r_{41}(\lambda_{41})$ |
|-------|----------------------|----------------------|
|       | $Se,\%$ | $Sp,\%$ | $Ac,\%$ | $Se,\%$ | $Sp,\%$ | $Ac,\%$ |
| $M_1$ | 68 | 60 | 64 | 69 | 62 | 63,5 |
| $M_2$ | 68 | 56 | 62 | 72 | 62 | 67 |
| $M_3$ | 76 | 68 | 72 | 92 | 80 | 86 |
| $M_4$ | 82 | 72 | 78 | 94 | 84 | 89 |

that corresponds to a good diagnostic test level.

**Conclusion**

The obtained data enable to assert that Muller-matrix mapping of optic anisotropic molecular endogenic fluorophors has a good level of the balanced accuracy for ACI diagnostics.

**Perspectives of further research**

Characteristics of Muller-matrix mapping of optically anisotropic molecular endogenic fluorophors that can be obtained by means of wavelet analysis are to be determined.

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