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MULLER-MATRIX MAPPING OF OPTICALLY ANISOTROPIC MOLECULAR ENDOGENIC FLUOROPHORS OF THE MYOCARDIUM IN THE DIAGNOSTICS OF ACUTE CORONARY INSUFFICIENCY

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Key words: *acute coronary insufficiency, postmortem diagnostics, autofluorescence.*

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.

The aim of the research

To establish diagnostic possibilities of the method of Muller-matrix mapping of optically anisotropic molecular endogenic fluorophors of the myocardium for ACI verification.

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, principle 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 autofluorescency 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_{41} and histograms of their values gets complicated,therefore calculation of the statistical moments of the 1-4 order of Muller-

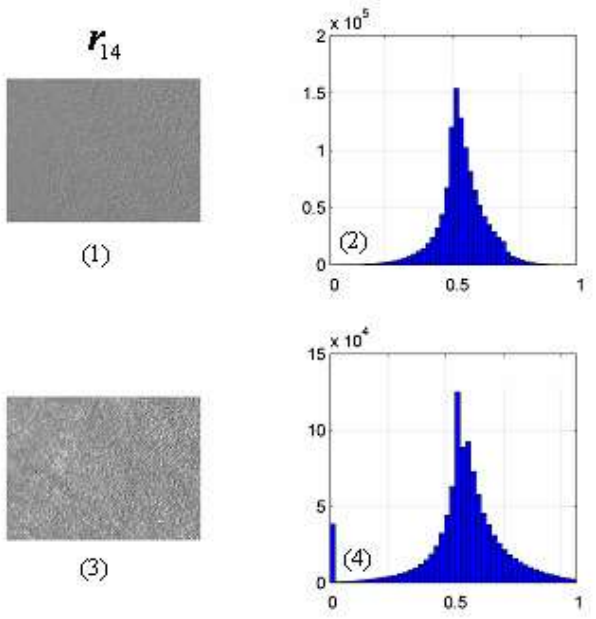

Fig.1. Coordinate distributions r14 and histograms of their values of the myocardium of both groups: 1 - coordinate distributions r_{14} at CIHD; 2 - coordinate distributions r_{14} at ACI; 3 - histogram of values $N(r_{14})$ at CIHD; 4- histogram of values $N(r_{14})$ at ACI.

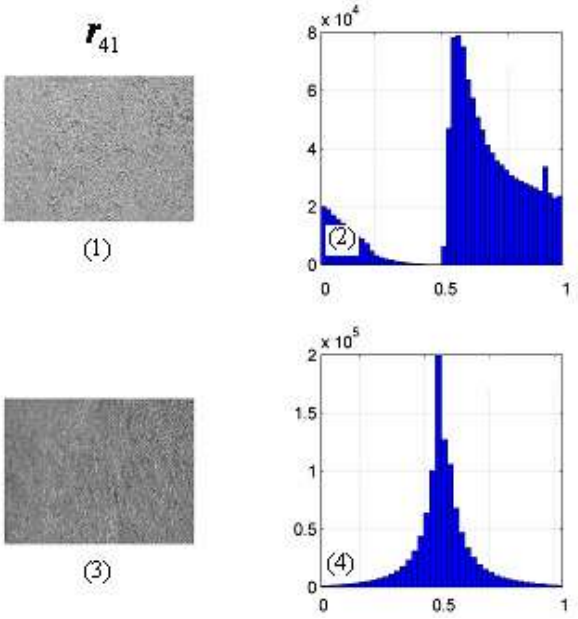

Fig.2. Coordinate distributions r41 and histograms of their values of the myocardium of both groups: 1 - coordinate distributions r_{41} at CIHD; 2 - coordinate distributions r_{41} at ACI; 3 - histogram of values $N(r_{41})$ at CIHD; 4- histogram of values $N(r_{41})$ at ACI.

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 $r_{14}(\lambda_f)$ and $r_{41}(\lambda_f)$:

- $r_{14}(\lambda_f)$: $\Delta M_1 \leftrightarrow 1{,}28$; $\Delta M_2 \leftrightarrow 1{,}28$; $\Delta M_3 \leftrightarrow 1{,}57$; $\Delta M_4 \leftrightarrow 1{,}75$;
- $r_{41}(\lambda_f)$: $\Delta M_1 \leftrightarrow 1{,}3$; $\Delta M_2 \leftrightarrow 1{,}69$; $\Delta M_3 \leftrightarrow 2{,}08$; $\Delta M_4 \leftrightarrow 2{,}91$

As it is obvious, statistical moments of the highest orders - asymmetry and excess, characterizing distribution $q \equiv \{r_{14;41}\}$ 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 of 1-4 order of Muller-matrix invariants r_{14} and r_{41} distribution for the method of laser fluorescent polarimetry

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

Operative Characteristics of Muller-matrix Fluorescent Mapping Method

M_i	$r_{14}(\lambda_f)$			$r_{41}(\lambda_f)$		
	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

hat 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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МЮЛЛЕР-МАТРИЧНЕ КАРТОГРАФУВАННЯ ОПТИЧНО АНІЗОТРОПНИХ МОЛЕКУЛЯРНИХ ЕНДОГЕННИХ ФЛУОРОФОРІВ МІОКАРДА У ДІАГНОСТИЦІ ГОСТРОЇ КОРОНАРНОЇ НЕДОСТАТНОСТІ

О.Я. Ванчуляк

Резюме. Проведено дослідження 69 зразків міокарда з гострою коронарною недостатністю (ГКН), 69 зразків із хронічною ішемічною хворобою серця та 20 зразків контрольної групи. Встановлено операційні характеристики Мюллер-матричного картографування оптично анізотропних молекулярних ендогенних флуорофорів міокарда порівняно із традиційним методом верифікації ГКН. Досліджуваний метод продемонстрував хороший рівень збалансованої точності для діагностики ГКН.

Ключові слова: гостра коронарна недостатність, посмертна діагностика, автофлуоресценція

МЮЛЛЕР-МАТРИЧНОЕ КАРТОГРАФИРОВАНИЯ ОПТИЧЕСКИ АНИЗОТРОПНЫХ МОЛЕКУЛЯРНЫХ ЭНДОГЕННЫХ ФЛУОРОФОРОВ МИОКАРДА В ДИАГНОСТИКЕ ОСТРОЙ КОРОНАРНОЙ НЕДОСТАТОЧНОСТИ

О.Я. Ванчуляк

Резюме. Проведено исследование 69 препаратов миокарда с острой коронарной недостаточностью (ОКН), 69 препаратов с хронической ишемической болезнью сердца и 20 препаратов контрольной группы. Установлено операционные характеристики мюллер-матричного картографирования оптически анизотропных молекулярных эндогенных флуорофоров миокарда по сравнению с традиционным методом верификации ОКН. Исследуемый метод продемонстрировал хороший уровень сбалансированной точности для диагностики ОКН.

Ключевые слова: острая коронарная недостаточность, посмертная диагностика, автофлуоресценция.

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