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INTELLECTUALIZED SYSTEM OF 2D- MULLER –MATRIX TOMOGRAPHY FOR DIAGNOSTICS OF FRACTIONAL LAYERS OF BIOLOGICAL TISSUE

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Abstract

The further progress of the methods of polarize-sensible optical coherent tomography may be associated with the development of new methods for analysis and processing the polarize nonhomogeneous images of the real multi-layer biological tissues (BT), which form the physiological organs. The issues of using the laser polarimetery for diagnosing the oncologic changes in the under-surface layers, shielded by other layers of biological tissues of this or the other human organ remain poorly researched.

Keywords: polarizing scanning, Muller matrix, experimental parameters, biological tissue.

Introduction

Our work is aimed at the experimental research of the possibilities of polarized reconstruction (tomography) of the coordinate distributions of Muller matrix elements of the under-surface layers of the smooth muscle, which is shielded by the layer of the conjunctive tissue, cervix of the uterus in the system of 2D-Muller –matrix tomography.

The architecture of the system contains the measuring (radiator**,** collimator, block of polarizing scanning, objecting bloch, projecting block, 6 polarized filters, block for registering and two-measuring data discretization), which forms the Muller matrix of the BT structure, as well as PC with special software. The latter realizes the algorithmic reproduction of the "orientational" and "phasic" 2D-distributions (tomograms) of the birefringence crystals in the net of polarizationaly reproduced under-surface layer and their analysis (statistical, correlation, fractal).

Optically-thin (weakening factor $\tau \le 0{,}1$) histological cryomicroscopic sections of the healthy and pathologically changed (cancerous state - dysplasia) tissue of the neck of uterus were used as the research material

As the diagnostic parameters of the Muller matrix of the neck of uterus tissue there had been chosen two of its diagonal elements y_{22} and y_{44}, which characterize correspondingly the "orientational" and "phasic" properties of the net of biological crystals of the layer of smooth muscle.

Results and their discussion. The table presents the values of statistical, correlation and spectral moments, which characterize the coordinate, autocorrelation and fractal distributions of the directly measured (optically-thin layers of the healthy tissue of the smooth muscle and in the state of dysplasia) and polarized reproduced (two-layers structure"smooth muscle– connecting tissue) of matrix elements $y^*_{22}(m\times n)$ і $y^*_{44}(m\times n)$.

Table

y_{ik}	y_{22}				y_{44}			
state	norm		pathology		norm		pathology	
$M^{(1)}$	0,31	0,27*	0,38	0,33*	0,25	0,21*	0,19	0,25*
$M^{(2)}$	0,18	0,2*	0,21	0,24*	0,14	0,1*	0,08	0,11*
$M^{(3)}$	0,31	0,36*	0,49	0,57*	0,29	0,19*	0,77	0,56*
$M^{(4)}$	3,35	3,91*	4,19,	4,71*	1,64	1,14*	6,19	4.99*
$Q^{(2)}$	0,22	0,24*	0,18	0,22*	0,18	0,23*	0,14	0,17*
$Q^{(4)}$	1,14	1,42*	1,43	1,59*	0,97	0,74*	1,85	1,11*
$J^{(1)}$	0,62	0,57*	0,55	0,63*	0,59	0,68*	0,66	0,72*
$J^{(2)}$	0,14	0,19*	0,16	0,22*	0,17	0,12*	0,34	0,28*
$J^{(3)}$	0,19	0,21*	0,27	0,24*	0,24	0,15*	0,41	0,29*
$J^{(4)}$	0,42	0,32*	0,48	0,36*	0,32	0,22*	0,57	0,36*

The analysis of the data shows that method of Muller matrix reproduction of the polarized properties of the optic – anisotropic structure of the smooth muscle in the multi-layer tissue of the uterus is of high efficiency – the maximal differences between the experimental parameters and polarizely reproduced do not exceed 35% - 45%.

It had been shown that the most diagnostically efficient for the differentiation of the optic properties of the healthy and oncologically changed layer of the tissue of the smooth muscle of the uterus are: 2-d, 3-d and 4-th statistic moments of coordinate distributions $y^{*}_{44}(m\times n)$ – differences between them are within 1,8 (M_2) - 4 (M_4) times; the 4-th correlation moment- differences between them are up to 2 times; 22-d, 3-d and 4-th spectral moments - differences between them are up to 1,65 – 2 times.

Conclusion. For Muller matrix images of the polarized reproduced orientation elements $y^{*}_{22}(m\times n)$ of the layer of the tissue of the smooth muscle of the uterus, the diagnostic efficiency of the method of polarized modulation tomography appeared to be insignificant, - the difference between the statistical $M_{i=1;2;3;4}$, corellational $Q_{i=2;4}$ and spectral $J_{i=1;2;3;4}$ parameters of the both groups of samples do not exceed 15% - 35%.

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