Diagnosis of cervical cytological smears for availability of papillomavirus by spectropolarimetry

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SPIE.
ATOM-N 2020

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INTRODUCTION

The diagnosis of background and precancerous lesions of the cervix is an actual problem in gynecology that needs new, innovative approaches[1]. Nowadays, complex method is widely used that includes colpocervicoscopy, cytological and histological examination. The recommendations of the International Union of anticancer it is noted that the use of cytology smears from the surface of the cervix and endocervical are one of the most effective cancer screening programs.

A huge amount of works both in the CIS and abroad are devoted to the problem of cervical diseases[2]. They are complemented by electronic microscopic, histochemical research techniques that represent undeniable novelty.

Methods of color and especially the evaluation of drug demand high qualification of morphologists. Even the presence of such experts in laboratories of gynecological clinics would not reduce the number of errors due to the presence of subjectivity in the interpretation of results.

The purpose is to demonstrate the possibility of laser diagnosis of cytological smears of the cervix for the presence of HPV using spectral-polarization methods.

METHODS

Morphological structure of the cervix in terms of laser optics can be represented as a two-component, amorphous and optically anisotropic (collagen fibers, muscle bundles) matrix which architectonics is described by Mueller matrix[3]. As noted above, the tissue of the cervix consists mainly of dense bundles of collagen fibers and mast cells. It is known that the occurrence of pathological processes of biological tissues is accompanied by the growth of collagen structures [3].

As the objects of modeling of radiation in multilayer structures and subsequent pilot study the following samples of biological tissues were used:
- smears and sections of the epithelial tissue of the cervix (SSC),
- scraping tissue of the cervix tissue (CT),
- test strains of cancer cells.

We conducted the comparison of the results of calculations and experimental studies of samples with results of histological analysis and cytochemical analysis for such types of structures of biological tissues:
- SSC (normal, dysplasia - three types, adenocarcinoma - three kinds),
- CT (normal, adenocarcinoma).

DIFFERENTIAL DIAGNOSIS OF NATIVE CERVIX DABS

Figure 1-2 presents the laser polarization image area phlegm normal squamous epithelium of eksocervix registered with coaxial and orthogonal orientations planes transmission polarizer and analyzer. Here in this figure are the corresponding histogram of distribution values of intensity field. Analysis of the polarization maps showed virtual absence of anisotropy values represented in the field of topology normal and ambiguity in assessing the intensity distribution histograms field. Therefore, we have expanded the pilot locations to 24 different states of polarization in the tanning and analyzing fields.
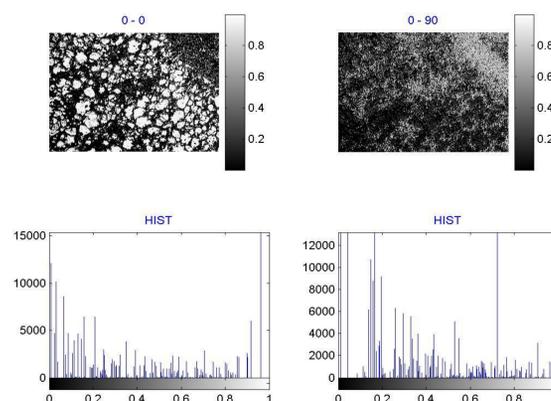
RESULTS

Figure 1. Laser polarization image of normal squamous epithelium of eksocervix which are registered with coaxial and orthogonal orientations of planes transmission of polarizer and analyzer
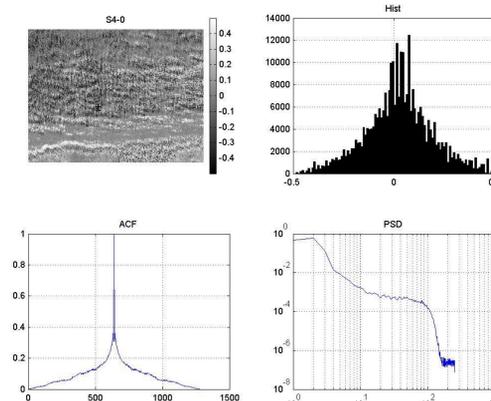

Figure 2. Coordinate distribution, statistic, correlation and fractal parameters of Stokes vector $S_4 (x, y)$ of polarization-inhomogeneous object fields smears from cervical scraping with squamous cell carcinoma of the cervix

Thus, the most sensitive diagnostic value were asymmetry and excess characterizing coordinate distribution "phase" Mueller matrix elements. All the above mentioned types of tissues and their consolidated statistical analysis on selected points higher order orientational phase-element Mueller matrix m_{34} are presented in Table 1. From this table, we can conclude that points of lower orders (m and σ) for these groups of tissues cannot be used for differential diagnosis.

Effect of change in morphological state as epithelium (for CIN 1-CIN 3) and collagen fibers of the stroma (for G1-G3) in the cancer changes lead to different (different from each other within two orders of magnitude) statistical distribution of images m_{34}, stock fluctuations in excellent correlation functions and structure of the power spectrum. Autocorrelation function for coordinate distribution of matrix elements m_{34} polarization-inhomogeneous samples of images as precancerous (CIN) and with cancer (G) contain statistical (monotonically decreasing) and oscillating components. The observed distributions of values multifractal elements m_{34}, calculated on a logarithmic dependence of the signal spectrum for these types of samples.

Table 1. Statistical moments of higher orders (Q_3 та Q_4) Mueller matrix elements m_{34}.

№	Groups of samples	Statistical moments of higher orders for m_{34} (x,y)	
		asymmetry Q_3	excess Q_4
1.	The samples of normal epithelium eksocervix outside the tumor margins (normal)	0,61 11%	0,45 11%
2.	Samples of tumor fields (low-grade dysplasia CIN1)	2,55 11%	0,65 11%
3.	Samples of tumor fields (highly differentiated dysplasia CIN2)	3,61 11%	0,98 11%
4.	Samples of tumor fields (highly differentiated dysplasia CIN 3)	3,84 11%	0,87 11%
5.	Samples of tumor fields (adenocarcinoma G1)	12,2 11%	0,93 11%
6.	Samples of tumor fields (adenocarcinoma G2)	14,5 11%	1,71 11%
7.	Samples of tumor fields (adenocarcinoma G2)	11,8 11%	0,84 11%

CONCLUSIONS

1. The use of spectropolarization studies and the fluorescence method will improve the accuracy of patient selection for the costly procedure - high-carcinogenic HPV DNA diagnosis by standard PCR.

2. It was analysed on this work the dependings of autocorrelation functions of coordinate distributions of the Stokes vector parameters polarization-inhomogeneous laser object fields of eksocervix native smears and cervical canal wall. It was revealed the behavior of power spectra distribution parameters Stokes vector of object field cervix.

3. It is established that the increase in the value of birefringence layers of epithelial dysplasia in biological tissues and networks of collagen fibers with adenocarcinoma manifested in the growth of statistical significance since the 3rd order coordinate distributions of polarization of laser images smears and tissue sections cervix. It is shown the informative polarimetric study of cervical cytology preparations, which grows in the following order: local polarimetry - statistical analysis after the first, second, third and fourth-order Stokes vector - the value of polarization dichroism.

4. Evaluation of statistical moments S_4 (x, y) Stokes vector parameter - asymmetry and excess reliably (r≤0,001) differentiated rate of cancer in cytological smear native and accurately distinguish adenocarcinoma from squamous cell cancer smears and cervical canal.

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