Laser correlation spectroscopy in the diagnosis of tumor diseases of the female reproductive system (preliminary results)

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Abstract. The study of blood serum of cancer patients by laser correlation spectroscopy to determine the possibility of differentiation of benign and malignant tumors of the female reproductive system. We analyzed the data and assessed the applicability of the method mentioned above target.

1. Introduction

Early diagnostics of malignant neoplasms is one of the most important problems of an oncology. The method of the laser correlation spectroscopy (LCS) is applied to detection of pathologies in a human body, allowing to obtain information on subfractional structure of extracellular vesicles in biological liquids. Extracellular vesicles perform an important role in information transfer between cells in an organism. They are involved in various physiological processes – both normal, and pathological. It is possible to determine absence or existence of any disturbances in a human body by structure and the size of vesicles [1, 2]. One of method of obtaining information on extracellular vesicles is the LKS method based on definition of spectral characteristics of the laser radiation disseminated when passing in disperse medium [3]. The program of data processing allows to visualize in the form of the histogram a percentage contribution to light scattering of separate fractions of biological liquid with hydrodynamic radiuses in the range from 1 nanometer to 104 nanometer. The method of a laser correlation spectroscopy has high sensitivity concerning detection of pathologies, including oncologic. In this regard it draws to itself (himself) more and more attention as a way of diagnostics of various diseases [4-8]. An opportunity to differentiate good-quality and malignant neoplasms is of great interest.

In work [9] it is experimentally shown that the histograms received by the LCS method from samples of a blood plasma of patients with benign tumors differ from the same histograms of patients with a breast cancer. The purpose of the real work is the research of a possibility of use of a method of a laser correlation spectroscopy of blood serum for differentiation of benign and malignant tumors of female reproductive system.
2. Materials and methods
20 women aged from 30 to 70 years were examined with the LSK method: 9 patients had benign tumors and 11 malignant ones. All patients were examined in the RCRC N.N. Blokhin department of gynecology and not been treated prior to the survey. Blood sampling, the subsequent preparation of blood serum and a further research were carried out in one day. Samples of a blood of 8 ml centrifuged 10 minutes at 3000 rpm. The received Serum was transferred to sterile plastic test tubes like Eppendorf of 1 ml. For carrying out measurement used 10% Serum solution (0.2 ml of Serum, 1.8 ml of water for injections). Solution was in a test tube at the room temperature of 20 °C of 10 minutes then the test tube was placed in a measuring cell of a spectrometer.

Measurements were taken on experimental installation in which the semiconductor VCSEL with a wavelength of 855 nanometers and a power output of 1 mW is a light source. The principle of work of LCS is based on definition of spectral characteristics of the monochromatic light scattered in disperse medium. Ranges of intensity’ fluctuations of diffused light processed mathematically the ProLSDRS program. As a result of processing received the histogram of particle distribution of blood serum by the sizes.

In each of samples of blood serum four measurements are taken. By means of the method described in work [10] two groups of particles were taped: to 100 nanometers and more than 200 nanometers. For each sample the average size of group of particles and weight in a percentage ratio bound to concentration are calculated. The obtained data averaged on all samples of Serum of patients with benign tumors and separately – on samples with malignant neoplasms. Differences as a part of blood serum of two groups of patients were determined by these parameters.

3. Results and discussion
For each sample of blood serum histograms of particle distribution by the sizes which characteristic type in case of benign and malignant tumors is given in fig. 1 were received.

![Figure 1](image)

**Figure 1.** Histograms of particle size distribution in the case of (a) benign and (b) malignant tumors.

The analysis of histograms of blood serum at patients with benign tumors was carried out. In histograms of all patients both on weight, and on intensity of dispersion of light particles with hydrodynamic radiuses of 10 - 50 nanometers over coarse particles > 200 nanometers prevail (table. 1). Existence of sharp dependence of intensity of light scattered on the size of suspended particles (in proportion to the sixth degree of the characteristic size) allows to measure reliably distribution of insignificant number of coarse particles against the background of fine. Therefore, in spite of the fact that concentration of fine particles considerably exceeds concentration large, average values of intensity of diffused light differ by one and a half times.

The similar analysis of histograms of blood serum of patients with malignant neoplasms showed that in dispersion of light coarse particles prevail > 200 nanometers over particles of the small size of 20-70 nanometers (table 2). Histograms on samples of blood serum of patients to malignant tumors are similar...
among themselves in particle distribution by the sizes. Only in one sample of a ratio between a contribution of two groups of particles to dispersion and their weight are similar to histograms of samples of blood serum of patients with benign tumors that is explained by specific features of the patient. Perhaps, such difference is bound to the fact that the tumor of this patient of low degree of malignancy, that is characterized by slow advance.

**Table 1.** The contribution of the two groups of serum particles in the scattering of light (%) and weight (%), averaged over all histograms patients with benign tumors.

| Particle contribution | 10 – 50 nm | 200 nm |
|-----------------------|-----------|--------|
|                       | The weight,% | Scattering,% | The weight,% | Scattering,% |
| The average contribution | 66,9 | 49,4 | 1,3 | 30,3 |
| The minimum contribution | 40,3 | 22,9 | 0,1 | 12,5 |
| The maximum contribution | 93,6 | 75,9 | 2,5 | 48,1 |

**Table 2.** The contribution of the two groups of serum particles in the scattering of light (%) and weight (%), averaged over all histograms patients with malignant tumors.

| Particle contribution | 20-70 nm | 200 nm |
|-----------------------|---------|--------|
|                       | The weight,% | Scattering,% | The weight,% | Scattering,% |
| The average contribution | 62,1 | 28,2 | 18,9 | 71,5 |
| The minimum contribution | 36,7 | 6,1 | 5,1 | 50,3 |
| The maximum contribution | 80,7 | 61,7 | 51,8 | 93,9 |

The group of particles of the small size in Serum ranges with malignant tumors is shifted to the area of larger sizes (20-70 nanometers) concerning the same group of particles in case of good-quality neoplasms (10-50 nanometers). Higher concentration of coarse particles which average value according to histograms of blood serum makes 19%, in comparison with average concentration of 1,3% of similar group of particles at benign tumors is observed. Most likely, such difference is bound to a high metabolic rate of clones of malignant cells and, respectively, allocation of larger number of large vesicles, unlike clones of good-quality cells.

High concentration of coarse particles with malignant tumors brings in blood serum of patients to is enlarged a contribution of these particles to light dispersion. In ranges it is shown in the form of larger intensity of diffused light from group of particles > 200 nanometers in comparison with intensity of
diffused light from particles of the small size. Blood serum ranges with benign tumors yield opposite result, and excess of intensity of diffused light from fine particles concerning intensity of diffused light from large.

The research of blood serum of patients showed that criteria of differentiation of good-quality and malignant neoplasms are: shift of group of particles of small hydrodynamic radiuses to the area of the larger sizes at malignant tumors and rising of concentration of coarse particles > 200 nanometers, and also change the relation of a contribution to intensity of dispersion of light between groups of particles: to 100 nanometers and more than 200 nanometers.

The LKS method allows to distinguish benign and malignant tumors of female reproductive system with high precision of 95%. The presented results are preliminary as selection of examinees isn't numerous, but results are very indicative. A set of the database proceeds.

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