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Polarimetry and Spectral Methods in Prediction of Children Disease after Adhesive Peritonitis

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Abstract

The aim of the study was to establish objective parameters of the field of laser and incoherent radiation of different spectral ranges (UV, visible, IR) as a non-invasive optical method of interaction with different samples of biological tissues and fluids of patients to determine the dynamics of peritonitis and choosing the best personal treatment. The objects of study were selected venous blood plasma of children and rats, histological sections of rat intestine in the postoperative period. As diagnostic methods have been used ultraviolet spectrometry samples of blood plasma in the liquid state, infrared spectroscopy middle range (2.5–25 microns) dry residue of plasma polarization and laser diagnostic technique of thin histological sections of biological tissues.

Keywords: peritonitis, biological tissues, blood plasma, UV spectroscopy, IR spectroscopy.

1. Introduction

The problem of adhesion formation, despite the long period of intensive study, and a large number of publications on this topic (Saravelos, 2007; Nogales, 2008), remains valid Postoperative adhesions break sharply quality of life for millions of people around the world, leading to complications with repeated operation accesses to the development of small bowel obstruction and chronic abdominal and pelvic pain. Currently, the basis of laboratory diagnosis of acute surgical diseases of the abdominal cavity is detecting changes of blood components as a quantitative values, and in a good state that accompany the development of inflammatory and destructive processes at both the local and at the system level. However, the accuracy of such a diagnosis is less than 70 %, as these criteria are obviously not characterized as inflammatory – destructive process as an individual response to it in each case. Therefore, the search for new, informative diagnostic parameter of acute surgical diseases of the abdominal cavity using non-invasive techniques such as spectral and polarization laser diagnostic techniques is becoming increasingly important (Nogales, 2008).

Also, equally important is to find simple and objective criteria that would provide an opportunity to assess the effectiveness of patient care in the postoperative period. In this paper examined the use for these purposes spectrometry method (Guminietsky, 1997), based on studies of UV absorption spectra of plasma venous blood as at the time of admission and in the postoperative period.

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plasma of children and rats, histological sections of rat intestine in the postoperative period. As diagnostic methods have been used ultraviolet spectrometry samples of blood plasma in the liquid state, infrared spectroscopy middle range (2.5-25 microns) dry residue of plasma polarization and laser diagnostic technique of thin histological sections of biological tissues.

2. Materials and methods

In this section reviewed the results of spectrophotometric method, based on studies of UV absorption spectra of plasma venous blood as at the time of admission and in the postoperative period. In total, the study involved 91 patients, operated on various forms of peritonitis, appendiceal origin. Among them were 44 children with local forms of peritonitis, 25 with diffuse peritonitis, 22 with diffuse peritonitis. 30 patients constituted the comparison group (combined treatment by traditional methods); 61 – the main group, they performed traditional treatment combined with the use of ozonized saline solution (0.9 % NaCl). The control group consisted of 28 children operated on inguinal hernia. According to a retrospective analysis conducted by us, 318 patient records (2001-2010), the NCS in 73.75 % of cases observed at the age of 7-14 years, as a control, primary and comparison group included patients of appropriate age.

The main group is divided into two subgroups:

- subgroup l (n = 31) – children, operated on the HVZ abdomen, which besides standard treatment was carried total blood irrigation of the abdominal cavity ozonized saline (0.9 % NaCl);
- subgroup 2 (n = 30) – children, operated on the HVZ of the abdominal cavity, in which the standard treatment is supplemented with intraoperative lavage of the abdominal cavity ozonized saline and intravenous ozonized saline (0.9 % NaCl).

Ozonation of saline 0.9 % NaCl treated by ozonation ozonizer for UM-80 for 15 min. When washing the abdominal cavity a solution with a concentration of 5 mg/liter in volume of 2 liters was used. The solution was removed from the abdominal cavity after washing. Used for intravenous solution with a concentration of 3-5 mg/l. Speed intravenous is 7 ml/min.

The object of study during ultraviolet spectrometry (UV-spectrometry) was venous blood plasma of patients who acted in BSMU in City Children's Hospital with the clinical peritonitis, appendiceal origin. Since blood plasma is optically inhomogeneous medium, the spectrophotometric studies to determine its absorption to account for light scattering technique we used spherical photometer with a prefix to the spectrophotometer SF-4 and SF-5[15-16]. The spectral resolution setup was 1.5-2.0 nm.

We studied the spectra of transmittance τ in the spectral range λ = 220-320 nm every 5 nm, followed by calculation of the optical density D according to the formula D =-lgτ. The choice of spectral range was made due to the fact that the electronic absorption spectra of all organic constituents of blood plasma are in the X <320 nm (Angelsky, 2006; Angelsky, 2003; Angelsky, 2002). Blood plasma taken from a peripheral vein and diluted with distilled water at a ratio of 1:100, filled with quartz k'yuvetu thickness of 1 cm and placed it in the center of the spherical photometer. The relative error of the obtained values of D at these experimental conditions in the long-wave maximum D absorption at λ, = 280 nm not more than 0.5 %. All measurements were carried out on fresh samples (up to 3 days), which prior to studies were stored at low temperature.

3. Results and discussion

It is shown that the development of acute surgical diseases of the abdominal cavity growth occurs mainly optical density D plasma compared to control (for donors) in the λ = 280 nm. Next, the results of researches UV absorption spectra of blood plasma and their changes during development of peritonitis, as in the case of severe inflammatory diseases relevant to in vivo studies are not possible. Measured absorption spectra of blood plasma in the spectral range λ = 220-320 nm, but since the information is an area adjacent to λ = 280 nm, the paper analyzed the results in the range λ = 250-320 nm.

Thus, the study of the spectral dependence of the optical density of plasma venous blood from wavelength measurements showed that the wavelength λ = 280 nm is a maximum optical density. From our point of view the dynamics of change of optical density plasma of venous blood in the λ = 280 nm is associated with the activity of plasma globulin, which include fibrinogen, which promotes the formation of adhesions in the abdominal cavity. This makes it possible to predict the development of adhesions in the abdominal cavity. Therefore, this spectral maximum

can be selected for testing of differences in optical density plasma used in the diagnostic evaluation of treatment methods.

The basis of spectroscopic methods is the measurement of the intensity of absorption, emission or scattering of light by a substance from the light frequency (or wavelength) (Angelsky, 2001; Angelsky, 2002). In optical absorption spectroscopy are used in infrared and ultraviolet regions, as well as Raman spectroscopy and luminescence spectra. Each spectrum corresponds to a certain wavelength. In different areas of light absorption has a different nature. Absorption of energy within the optical spectrum varies the rotational, vibrational energy of molecules or excitation energy external valence electrons. To improve the rotational energy of the molecule is relatively small enough energy corresponding absorption lies in the far infrared (IR) region (the region of large wavelengths). To increase the vibrational energy of the molecule (to excite vibrations of atoms relative to each other) need large quantities of photons and the absorption is in the near infrared region. Even greater quanta of energy required to excite outer electrons of the molecule – absorption in the visible and ultraviolet region. The method of spectroscopic analysis was used to determine the amount of the substance. The Beer-Lambert law – one of the fundamental laws of spectroscopy, says, "The absorption of light is proportional to the number of molecules absorbing material on its way".

In the IR spectrum are four areas: I – visible, 2 – near, 3 – and 4 fundamental, far away. To study the organic matter is most important fundamental infrared region, which lies in the range from 5000 to 200 cm^{-1}. Lines in the 600-1300 cm^{-1} are excellent and even specific related molecules, so it is called the area "fingerprint" of the molecule. In this area fall into a single bond stretching vibrations of C=O, C=N, N=O. On the contrary, the absorption frequency of double bonds C=C, C=O, N=O was characterized, that is a little different for different molecules and lie in the 1500-1950 cm^{-1}. Absorption of triple bonds is even more short-wave region (for C=C at 2100-2250 cm^{-1}) IR spectrum is quite specific property of each chemical compound, as well as position isomers, geometric isomers and molecules containing protons have different spectra. In this regard, the IR spectrum of each substance has a distinct pattern.

IR spectra were used to identify the compounds and establish their degree of purity (quality) and they can be used for qualitative analysis of mixtures for controlling the progress of the reaction. However, the most common and important application of IR spectra is the clarification and confirmation of the intended structure of the compounds. The presence of almost any functional group in a molecule can be set through them. Also the possibility of using infrared spectroscopy and quantitative analysis is considered.

In our experimental setup spectrum recorded automatically and used to measure infrared spectrophotometer “Specord 80/851R” provided the photometric accuracy of ± 0,2 %. The control program embedded computer prevents incorrect and inconsistent parameter provides a linear correlation between basal line 10 wave numbers.

These factors ensure objectivity and high precision spectroscopic analyzes.

The current level of knowledge in the field of spectroscopy can determine the appearance of new ("pathological") and the disappearance of "normal" chemical substances (ATP, GTP, UTP, etc.) that are in various pathological conditions subject to rapid metabolism to form the corresponding hydrolysis products – monophosphate. Also it is possible to determine the concentration of protein molecules and phosphatides in the process of disintegration of cellular structures. In the studied area the infrared spectrum of fall and valence bonds free radicals.

Thus, infrared spectroscopy can be used to determine the level of several metabolites formed during pathological changes initiated by the inflammatory process and thus to assess the degree of metabolic processes.

In our opinion the most important is not to determine the amount of a substance (including a huge number of them), which is found in the blood of a sick child, and the correlation integral indicators infrared spectroscopic analysis of the severity of the inflammatory process and thus the level of metabolic disorders.

As an object of research using blood serum (healthy) children, prepared for spectral analysis (Angelsky, 2005; Angelsky, 2012; Guminestskij, 2006; Angelskaya, 2013). Serum was dried at room temperature for half – a petri dish. The dry residue was injected into the liquid paraffin and received a suspension, which is then subjected to IR-spectroscopy recording absorption spectra in the region 1200-1000cm^{-1}. Upon receipt of spectrogram peaks measured the height of the

absorption bands with maxima at 1170, 1 165, 1 150, 1140, 1130, 1100, 1070, 1025 cm^{-1} and calculated the average height of all peaks - C. Then determine the ratio of each peak prior to the subsequent: 1170/1165, 1165/1150, 1150/1140, 1140/1130, 1130/1100, 1100/1070, 1070/1025.

Informative values denote conditional symbols (M, m, D, c, R, x, S). Index M is the largest value obtained, and the index m - minimum. Also introduced an additional parameter – D, which is the difference between M and N. The mean of all values marked as indicator – p. Also calculated value of R – the ratio of peak height with a maximum at 1165 cm^{-1} to the height of the peak maximum at 1170 cm^{-1}, the value of x – the ratio of peak height with a maximum at 1130 cm^{-1} and the average value of the heights of peaks (C) and size S – the ratio of peak height with a maximum at 1100 cm^{-1} to the mean value of height (C).

In Fig. 1-4 is shown the infrared spectra of plasma venous blood of patients 1 and 2 on the 3rd and 7th day of treatment. Aligned spectra are characterized by absorption bands, among which we isolated two – first 1000-1800 cm^{-1} and the second 2800-3500 cm^{-1}. Characteristic was the difference in the behavior of the absorption spectrum in the region 1300-1700 cm^{-1} for patients of the 2nd subgroup 2 for different periods of treatment.

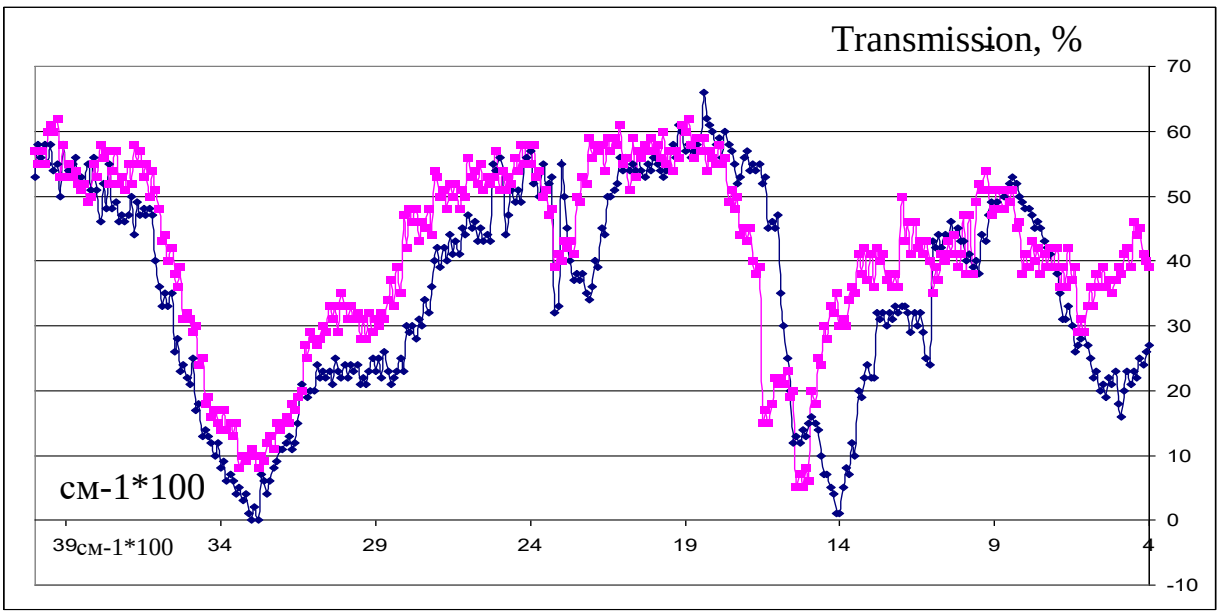

Fig. 1. IR transmission spectra of plasma venous blood of patients in group 2–1st subgroup on the 3rd and 7th day of treatment

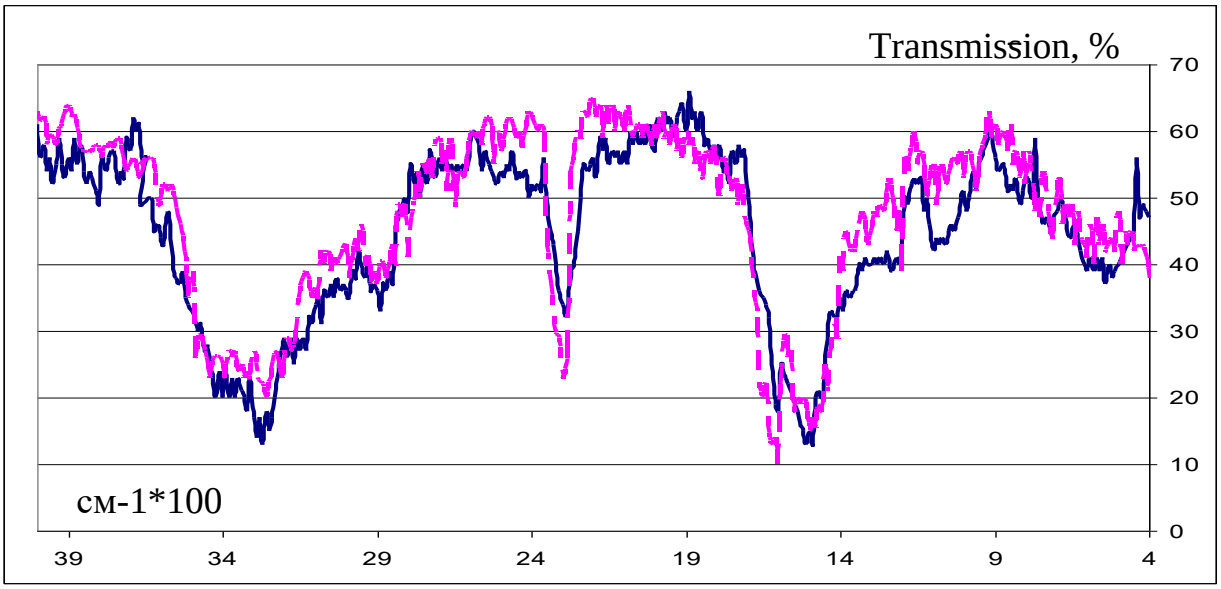

Fig. 2. IR transmission spectra of plasma venous blood of patients in group 2–2nd subgroup on the 3rd and 7th day of treatment

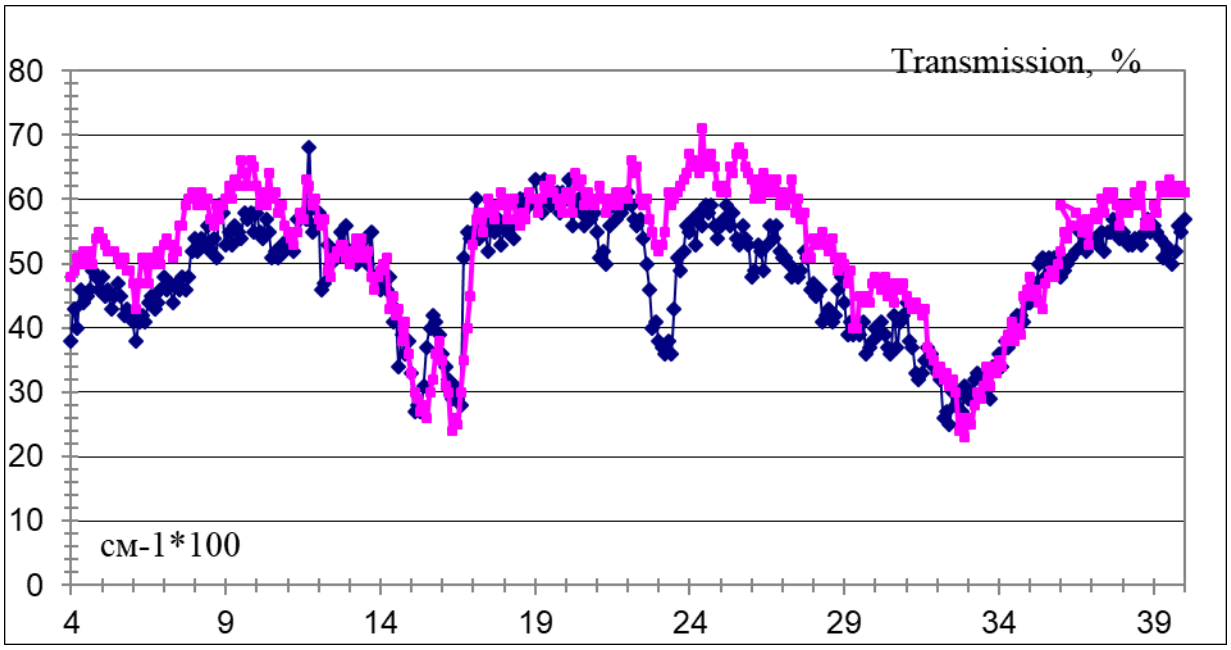

Fig. 3. IR transmission spectra of plasma venous blood of patients in group 1 on the 3rd and 7th day of treatment

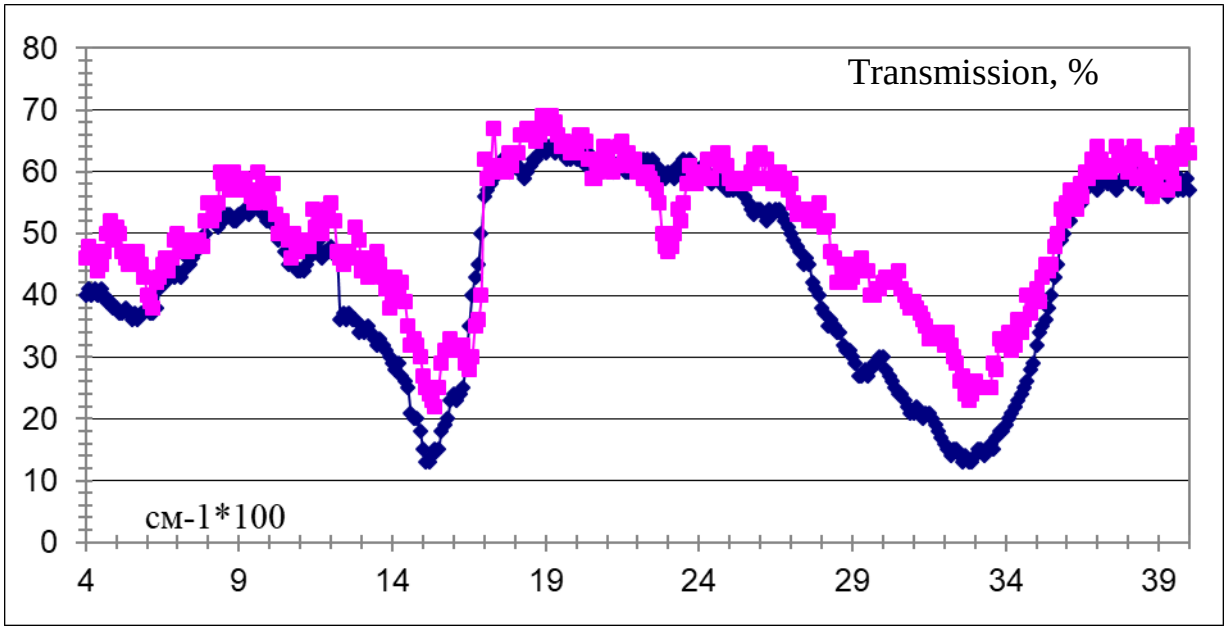

Fig. 4. IR transmission spectra of plasma venous blood of patients in the control group at 3 rd and 7 th day of treatment

In order to determine the values of IR spectroscopic parameters determined their range of children patients at the 3rd and 7th day of treatment. To do this, select the numerical values of each of the parameters in Table 1.

Table 1. Numerical values for IR- spectroscopy in children with peritonitis.

Values	IR spectroscopic parameters					
	D	M	*m*	R	S	*x*
Control group	0,55	1,23	0,30	0,43	0,50	0,45
1-st group	2,50	2,88	0,70	0,88	0,80	0,86
1st group, subgroup 1	0,75	3,23	0,10	0,4	0,52	0,5
2st group, subgroup 2	1,50	1,88	0,25	0,38	0,58	0,6

The results showed that using the method of IR spectroscopy in the frequency range 400-4000 cm^{-1} revealed the quantitative parameters of the degree of absorption of blood plasma of patients in different bands that will in the future conduct rapid analysis of the patient during his treatment at the time and technique to make choices treatment.

By using the method of IR spectroscopy were able to establish the effectiveness of the combined use of ozonized saline over the first 2 groups and 2 subgroups (washing + in/in the introduction of ozone) compared with the first subgroup (washing with ozone) 2 groups and nearly approach the targets in relation to prediction formation of adhesions in the abdominal cavity.

4. Conclusion

1. Thus, our study in this paper the spectral dependence of the optical density of plasma venous blood from wavelength measurements showed that the wavelength λ = 280 nm is a maximum optical density. From our point of view the dynamics of change of optical density plasma of venous blood in the λ = 280 nm is associated with the activity of plasma globulin, which include fibrinogen, which promotes the formation of adhesions in the abdominal cavity. This makes it possible to predict the development of adhesions in the abdominal cavity. Therefore, this spectral maximum can be selected for testing of differences in optical density plasma used in the diagnostic evaluation of treatment methods.

2. Using infrared spectroscopy in the frequency range 400-4000 cm^{-1} revealed the degree of absorption of quantitative parameters of blood plasma of patients in different bands that will in the future conduct rapid analysis of the patient during his treatment in time and make a choice method of treatment. By using the method of IR spectroscopy were able to establish the effectiveness of the combined use of ozonized saline over the first 2 groups and 2 subgroups (washing + in/in the introduction of ozone) compared with the first subgroup (washing with ozone) 2 groups and nearly approach the targets in relation to prediction formation of adhesions in the abdominal cavity.

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