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LAZER-POLARIMETRIC METHODS OF INVESTIGATION OF BIOLOGICAL TISSUES IN FORENSIC MEDICINE - PERSPECTIVES, REALITIES AND THE FUTURE

Key words: *lazer polarimetry, prescription of death coming, time forming hematomas.*

Abstract. T*he results of the scientific achievements in the field of forensic medical examination and physics have been elucidated in the article. The aim of the research was the search and development of the latest lazer polarimetric criteria of diagnostics of intravital and postmortem changes of biological tissues and media of a human being to solve the questions of forensic medicine science and practice, specifically determination of the prescription of death coming at its different causes, time of hematoma forming, intravital formation of bodily harms and diagnostics of myocardial ischemia. Investigation of biological tissues (samples of the skin, skeletal and cardiac muscles, brain, lungs, liver, kidneys, spleen and small intestine) and hematomas of the organs (brain, liver, kidneys, spleen) by lazer polarimetric methods with the subsequent statistical processing of the results were conducted during the research. The result of the scientists'work has become studying and mastering a number of physical methods, successfully and effectively used, to realize the purpose which was set: lazer statistical polarimetry of postmortem pictures of the native tissue sections of the cadavers; polarizational mapping of postmortem pictures of the native tissue sections of the cadavers; elements of Muller's matrix, Stoks polarimetry of postmortem pictures of the native tissue sections of the cadavers; methods of polarizational matrix; a number of methods of spectral phasometry of lazer pictures, statistical analysis of coordinate distribution of a degree of depolarization and phase displacements, statistical, correlative and fractal approaches in analysis of lazer pictures of biological tissues and organism media. A number of peculiarities and appropriatenesses of change of lazer beam properties as a result of passing through biological tissue has been established and schemes of studying different types of tissues have been founded when carrying out and numerical investigations. A complex of objective forensic-medical methods and criteria of determination of prescription of death coming at its different kinds, time for forming hematomas, intravital formations of bodily harms and diagnostics of acute myocardial ischemia have been substantiated.*

Introduction

To the end of the XX century delimitation of the scientific investigation into particular disciplinary directions exhausted its potential and became unpromising, that is why interdisciplinary integration is a world- wide tendency to develop on principle, the latest criteria, that will be the basis for the solution of complicated medico-biological problems. The staff of the Department of forensic Medicine and Medical Law headed by professor V.T. Bachynsky came to decision to combine their intellectual work with the staff of the department of optics and spectroscopy of engineering technical faculty headed by professor O.G. Ushenko of Yu. Fedkovych National University in order to put the latest interdisciplinary scientific investigations in the field of forensic medical examination and optical physics into effect. Discoveries expressed in dissertation investigation of V.T. Bachynskiy, I.L. Bezhenar, O.Ya. Vanchuliak, O.V. Pavliukovych and dedicated to the urgent questions of forensic medicine have become the results of their fruitful cooperation.

Purpose of the research

Search and development of the latest lazer polarimetric criteria of diagnostics of intravital and postmortem changes of biological tissues and media of a human being in order to solve the problems of forensic medical science and practice, specifically determination of the prescription of death coming at its different causes, time of hematoma forming, intravital formations of bodily harms, diagnostic of acute myocardial ischemia.

Modern approach to the structural organization of biological tissues

The whole complex of biological tissues (BT) may be respresented as totality of fibrillary protein structures, that form its unique structural - functional organization. Significant peculiarity of the given fibrillary proteins is their precise regulating that gives them properties of liquid crystals. It is known that liquid crystals are substances that simultaneously manifest fluidity of liquids and crystals, molecules of which are, in a certain manner, regulated, that is there is a definite symmetry. As a result, there is anisotropy of mechanical, electrical, magnetic and optical properties of this class of substances. Just, anisotropy of optical properties may be revealed by the methods of lazer polarimetry. Biological liquid crystals have a distant order, their molecules are dislocated concerning each other under a constant angle, thus, they are cholesteric (fig. 1.)

Collagenic chains are interlaced, forming triple spiral. If they are zigzagging packed into layers, then the system of hollows is formed making them even upward. The following layer of the triple spiral can get any of two steady positions. They may be (a) parallel to the initial layer in the hollows between triple spirals or (b) in the hollows that lie at an angle to initial layer. Architectonics of the dermal layer is formed by the groups of collagenous fibrils (fig. 2.)

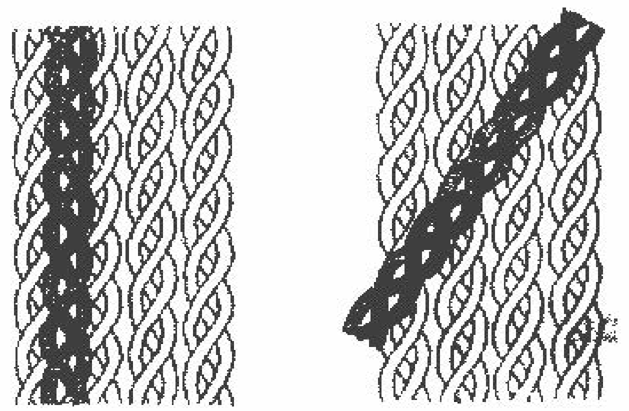


Fig.1. Possible relation between molecular component (a) and angular rotation (b) in collagen (Nevil model)

Coaxial fibrils form not only collagenic but elastin and myosin fibers. From this position the muscular tissue is nothing more as spatial regulated (arranged, ordered) system of (protein) fibres, which consist of optically isotropic actin and anisotropic myosin (fig. 3.)

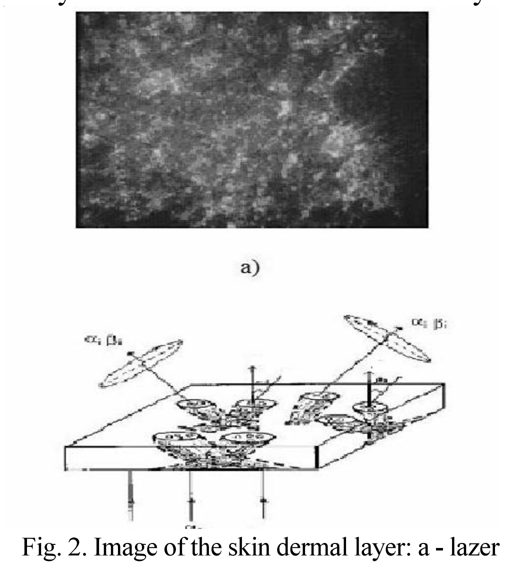


Fig. 2. Image of the skin dermal layer: a - lazer polarizational image; б - optic model. Where α_0- azimuth of polarization of probing lazer wave; α_i,β_i - azimuth and ellipticity of polarization of image points

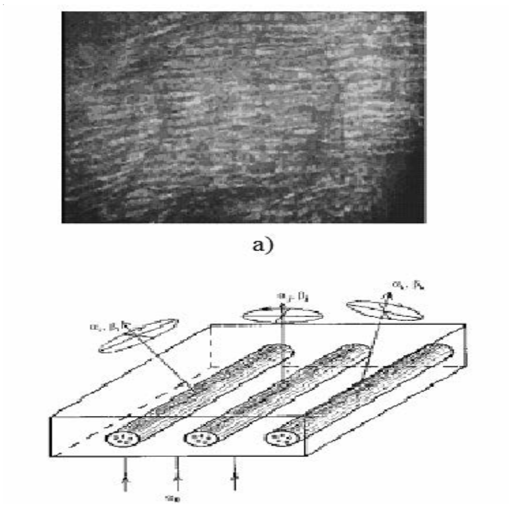


Fig. 3. Muscular tissue layer of a man (a) and its optic model (b). α_0- azimuth of polarization of probing lazer wave; α_i,β_i - azimuth and ellipticity of polarization of image points

The data, cited above, induced us to further conduction of the latest scientific investigations in the field of morphology and physics.

Physical fundamentals of investigation of biological tissues

Mechanisms of interaction of lazer eradiation with the layer of structural BT or organism's media (OM) is described by means of Muller's matrix for optically crystals with one axis.

Here - fibril orientation, which determines a direction of optic axis of biological crystal; - value of phase displacement, inserted between orthogenic components of the lazer wave amplitude (fig. 4.)

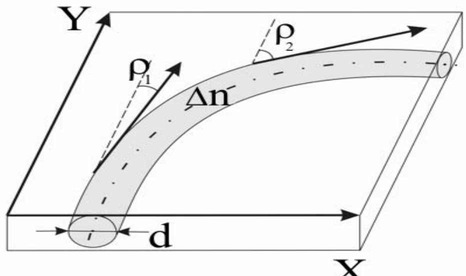


Fig. 4. Double-refracting fibril with diameter of cut

Here - fibril orientation, which determines a direction of optic axis of biological crystal; - value of phase displacement, inserted between orthogenic components of the lazer wave amplitude (fig. 4.)

Polarizational parameters (azimuth and ellipticity of lazer bundle are defined according to such algoryhths) [1]:

$$\alpha = 0{,}5 arctg\left[\frac{\sin 4\rho \sin^2 0{,}5\delta}{\cos^2 2\rho + \sin^2 2\rho \cos\delta}\right]; \qquad (1)$$

$$\beta = 0{,}5 \arcsin\left[\frac{tg 2\rho}{\sin\delta}\right]. \qquad (2)$$

Physical modeling of hematomas a man has a certain distinction. A real hematoma may be represented in the form of combination of consecutively arranged - two-refracting monolayers. Thus, man's hematomas start as smectic crystals. Polarizational properties of each layer are characterized by matrix appearance (1).

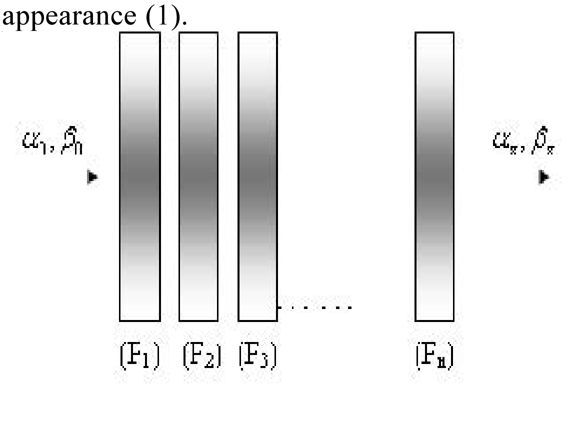


Fig. 5. Stratified optic model of hematomas

In such situation Muller's matrix of hematoma may be defined in the from of a product of corresponding partial matrixes $\{F\}_{i=1-N}$

$$\{Z\} = \{F\}_N \{F\}_{N-1} \ldots \{F\}_2 \{F\}_1 \quad (3)$$

Materials and Methods

Investigations of BT and MO of the deceased were carried out in the building of morgue of the Chernivtsi regional bureau of forensic medical examination while performing researches at air temperature of 18-21°C and air humidity 60-80%. Native sections of 20-100 mcm thickness (depending on tissue kind) were got by means of a freezing microtome from the separated pieces. Radiation of the objects under study was carried out in layer installation (with different wave length) and auxillary equipment (fig. 6.)

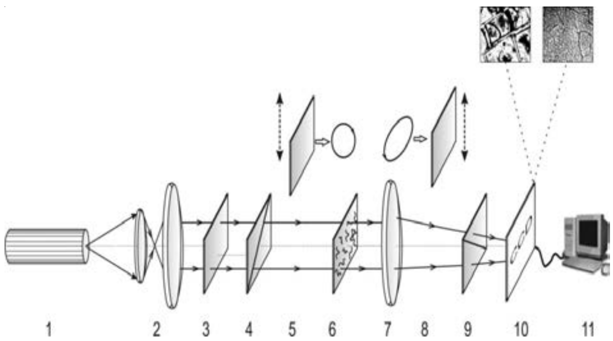


Fig. 6. Optic scheme of polarimeter: 1 - He-Ne lazer; 2 - collimator; 3 - stationary quarter-wave-length plate; 4 - polarizer; 5 -mechanically movable quarter-wave-length plate; 6 - subject of investigation; 7 - microobject-glass (lens); 8 - mechanically movable quarter-wave-length plate; 9 - analyser; 10 - CCD-camera; 11 - personal computer

The results obtained were calculated according to the standard algorithms of the programme products MATLAB and Statistica.

The following sampling was carried out for investigation:

- BT: skin of the anterior wall of the abdomen, cross-striated muscles of the abdomen (direct), cardiac muscles tissue of the brain, lungs, liver, kidneys, spleen, small intestine for studying the prescription of death coming (PDC) because of different causes;

- hematomas of the organs: brain, liver, kidneys, spleen, skeletal muscle - to determine the time of hematomas' forming;

- cardiac muscle - for determination of ischemia areas;

- skin sample from the areas of abrasion - to determine vitality of the formation of bodily harms.

Results of the investigation discussion.

1.Determination of the time hematomas formation of in BT.

Investigation of polarizational and phase parameters of hematomas of man's internal organs using statistical and correlative approaches, in particular liver (fig. 7), was carried out.

Polarizational images of the sections of liver's hematomas in 1 and 24 hours from the time of their formation are presented in fig. 8. Elipticity coordinate distribution of polarization images are shown in the lower part.

The adduced data demonstrate objective change of lazer polarimetric images of hematomas at different periods of time after death that may be used for determination of the prescription of death coming (PDC).

Hour-long dynamics of lazer polarimetric characteristics of BT.

Investigation of distribution of the combination importance of azimuths and elipticities of polarization images of BT and MO of a man with the subsequent statistical processing were carried out with the object of getting systematic information about the polarizational structure change.

The result of the research will be shown on the example of the muscular tissue (MT) of man's cadaver. Polarizational images of muscular tissue, obtained for different hour-long periods after the

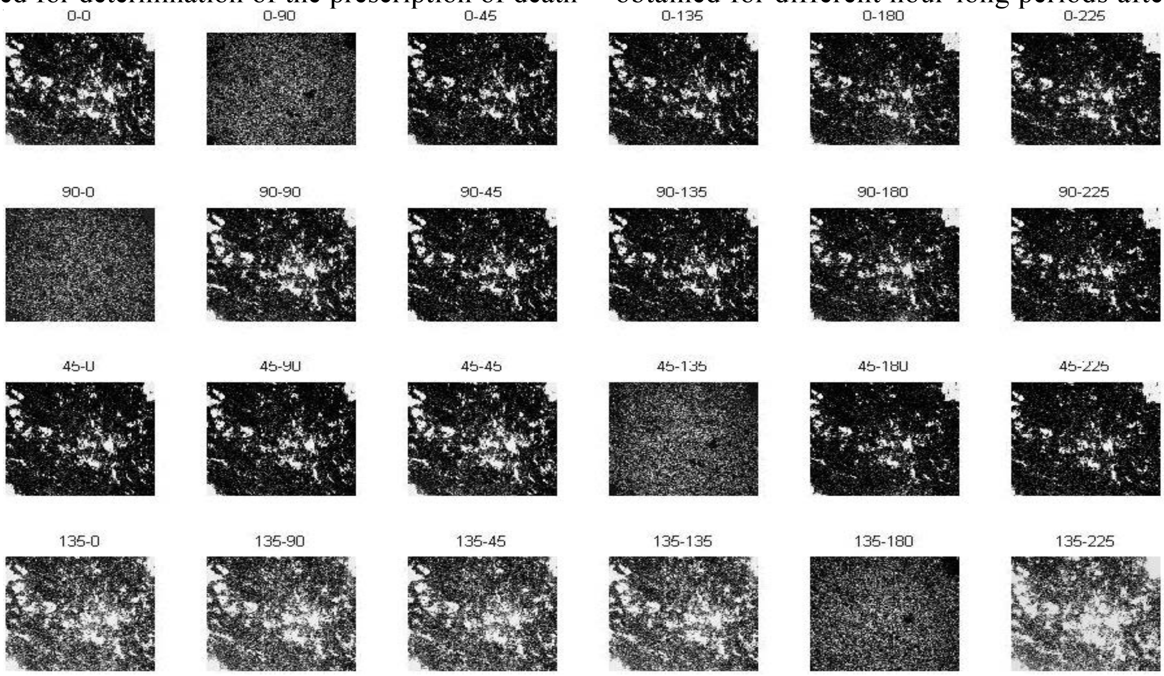


Fig. 7. Polarizational structure of hematomas, lazer images of parenchymatous organ hematomas (human liver).

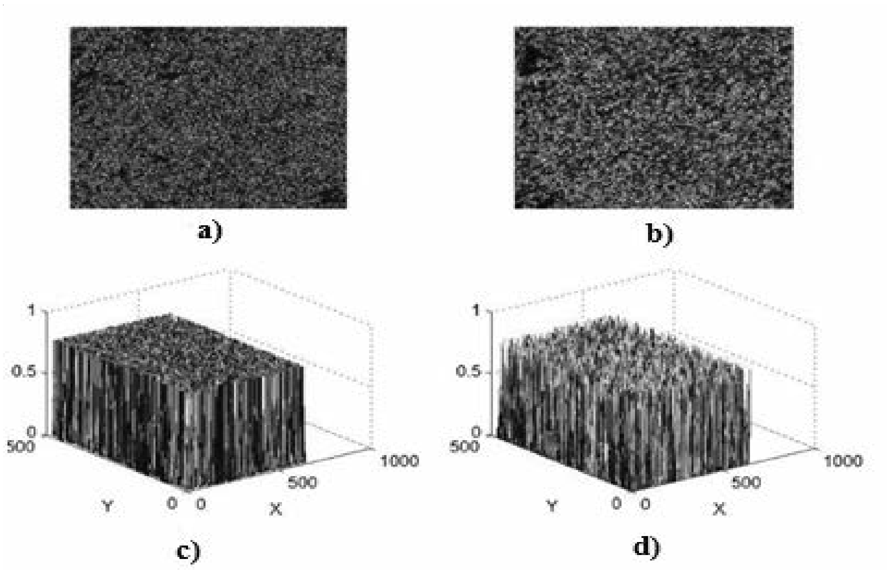


Fig. 8. Lazer polarimetric images of the liver's hematomas:
a - two-measurable polarization allocations of elipticity lazer images in 1 hour; b - three-measurable polarization distributions of elipticity lazer images elipticity in 1 hour; c - two-measurable polarization distributions of elipticity lazer images in 24 hour; d - three-measurable polarization distributions of elipticity lazer images in 24 hour.

prescription of death coming, are shown in series of microphotographs (fig. 9).

Quantitatively such changes characterize histograms of the meanings distribution of azimuths and elipticity of polarization, measured in lazer images MT, and are given in fig. 10 and 11.

From the data obtained it is seen that hour-long dynamics of the cadaver changes of MT structure result in substantial decrease of optic anisotropy. Probabilities of polarization casual meanings of azimuths and elipticity with an increase of the time of observation following the death coming have an expressive tendency to re-distribution till minimum values.

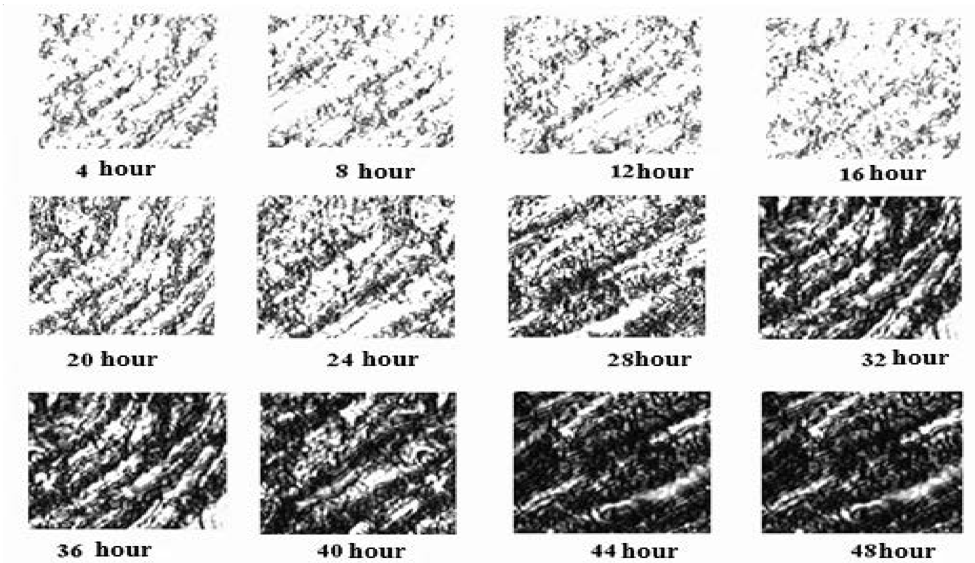
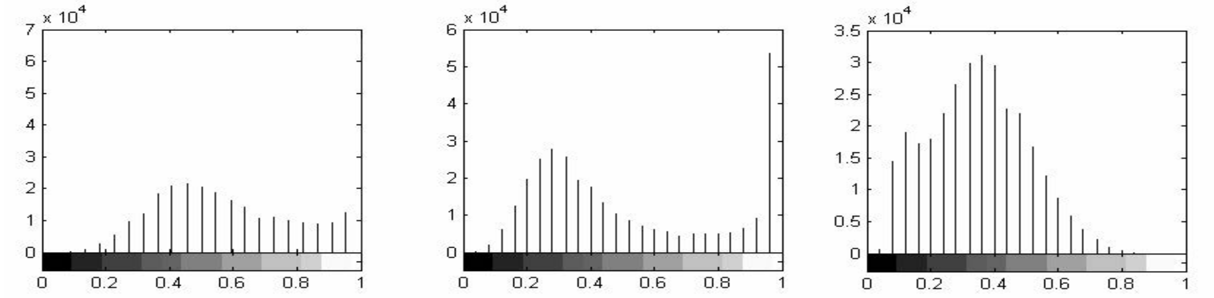


Fig. 9. Polarizational images of muscular tissue for different hour-long period of PDC.



a) b) c)

Fig. 10. Statistics of azimuths' distribution of polarization of architectonics MT images: a) - 1 hour; b) - 6 hour; c) - 24 hour.

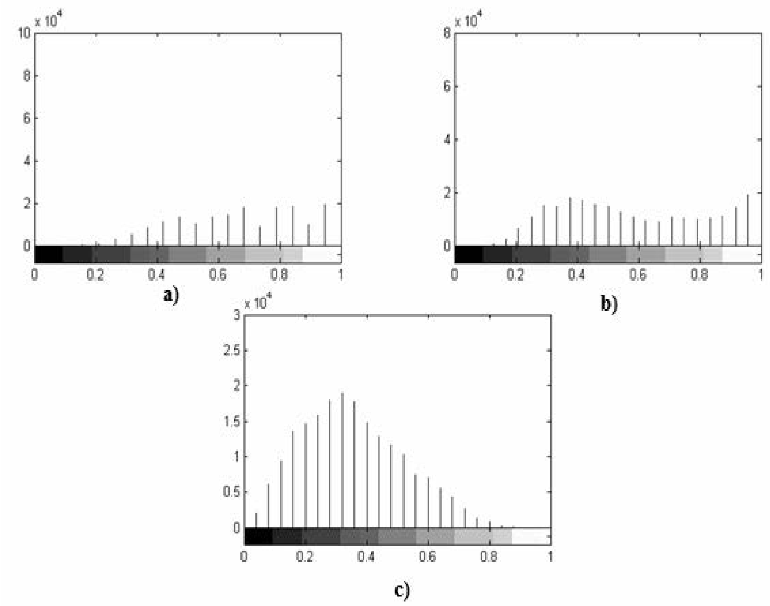


Fig. 11. Statistics of elipticity distribution of polarization of architectonics MT images: a) - 1 hour; b) - 6 hour; c) - 24 hour

Hour-long dependency of polarizational parametrs $\Delta \alpha^0$ (curve 1), $\Delta\beta^0$ (curve 2) of MT images changes are shown in fig. 12.

Space narrowing of casual change of the parameters $\Delta\alpha^0$, $\Delta\beta^0$ with an increase of time after the death coming may be connected with level decrease of optic anisotropy of architectonics MT and used as diagnostic time parameter of death coming.

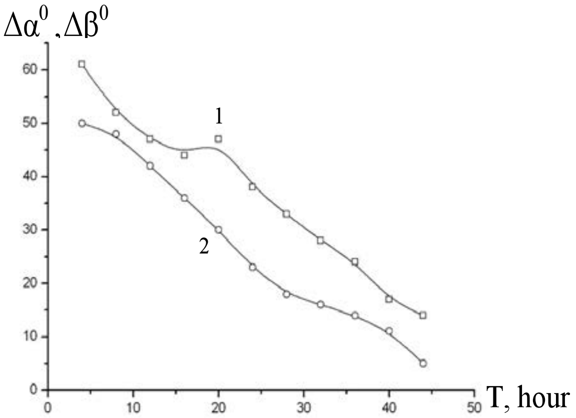


Fig. 12. Hour-long dependencies of polarizational parameters changes of MT images: 1 - hour-long dependency of parameter $\Delta\alpha^0$; 2 - hour-long dependency of $\Delta\beta^0$ parameter

As a result, we have established hour-long range of PDC detection, stipulated by peculiarities of postmortem changes of lazer images MT, from 1-140 hours and exactness of determination - 1,5 hour.

Determination of intravital formation of a person's skin damage.

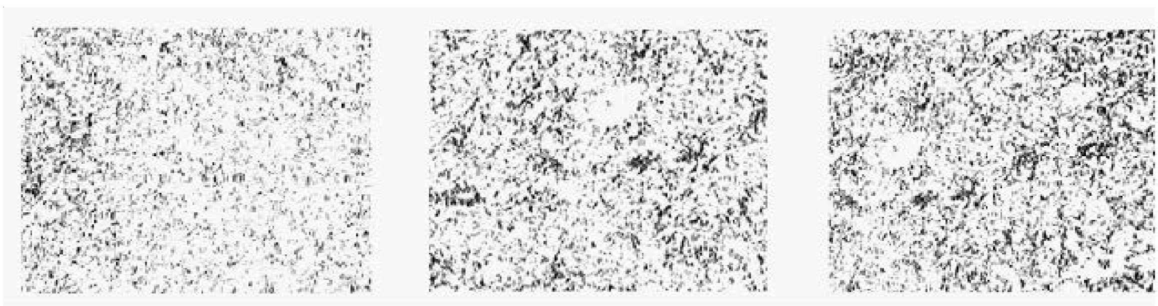
Urgent task of forensic medicine is not only determination of the fact of damage availability, but relation of its formation to the moment of the death coming, that is, determination of the fact of its intravital or postmortem origin.

To solve the given question we have decided to develop objective criteria for the differentiation of intravital or postmortem cause of damages according to lazer photometry, polarimetry and phasometer of a person's skin on the basis of statistical and spatial frequency analysis of lazer images of histological section of the dermal layer.

Scale increased selection of intensity distribution of lazer images of histological sections of a person's skin of all types and their three - measurable reconstruction are presented in fig. 13-14.

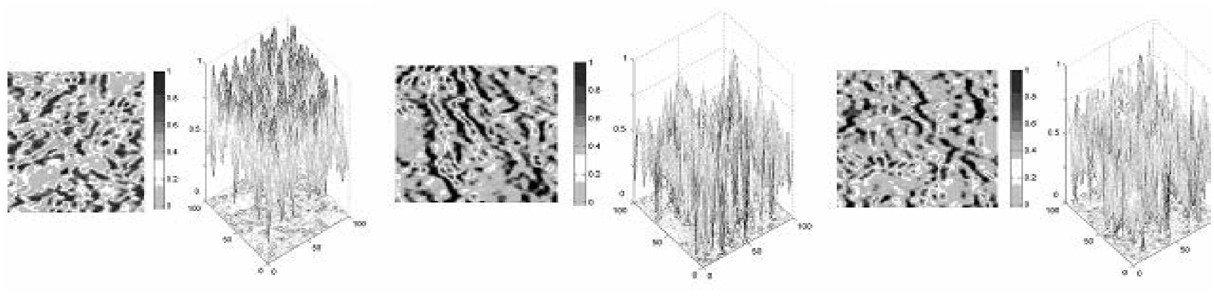
From the comparative analysis it is obvious that the value of the extreme local intensity in the area of abrasion is significantly less than meaning in the image of noninjured areas. This peculiarity may be explained by haemorrhage presence in the zone of abrasion, that are optically shown in radiation absorption. Thus, intensity of images in such places is less than in the areas without internal haemorrhages.

Later on we have carried out a statistical analysis of coordinate distributions of lazer images of histological cutaneous cuts of all types.



a) b) c)

Fig. 13. Lazer images of histological sections of man's skin: a) - noninjured skin; b) - intravital abrasion; c) - postmortem abrasion



a) b) c)

Fig. 14. Three-measurable reconstruction of intensity distribution of lazer image of the cuts of humans skin: a) - noninjured skin; b) - intravital abrasion; c) - postmortem abrasion.

As a result we have got correlation between the formation of abrasions during the life-time or after death and statistical (average and dispersion) and spatial frequency (dispersion of extremes Log-log dependencies of spectrum intensity) parameters, that characterize coordinate distributions of intensity, azimuths, elipticity phase displacements between orthogenic components of lazer wave in the images of man's skin.

Investigations of lazer polarimetric properties of biological tissues of the organism media at the presence of mechanical asphyxia and acute hemorrhage.

The next stage of our research was to study BT and MO changes under conditions of mechanical asphyxia (MA) and acute hemorrhage (AH) citing as an example polarizational images of myocardium tissue (Fig. 15).

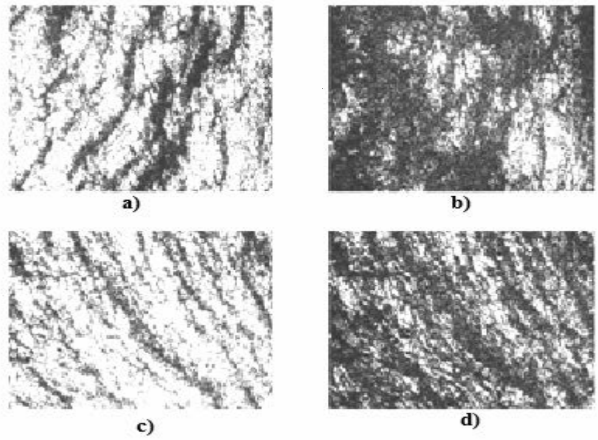


Fig.15. Polarizational images of myocardial tissue: a - in axised polarizer and analyzer at mechanical asphyxia; b - in crossing polarizer and analyzer in case of mechanical asphyxia; c - in axised polarizer and analyzer at acute hemorrhage; d - crossing polarizer and analyzer at acute hemorrhage

Analyzing the obtained polarizational images of the myocardial tissue MT (Fig. 15) the following phenomenon have been revealed: polarizationally visualized TM images in crossing polarizer and analyzer point to the presence of "enlightenment" at the expense of the formation of elliptically polarized or depolarized waves in hemorrhage areas.

Experimentally measured coordinate distributions of the degree values of depolarized lazer eradication, dispersed TM under conditions of MA and AH are adduced in fig. 16.

It has been revealed that coordinate distributions of depolarization degree of TM lazer eradication at MA is characterized by the areas with significantly greater level of polarization (Fig. 16a) than analogous distributions, determined for TM at AH (Fig. 16b), that is connected with different pulse volume.

Objective statistical description of coordinate distributions of depolarization degree of lazer eradication is represented in Table 1.

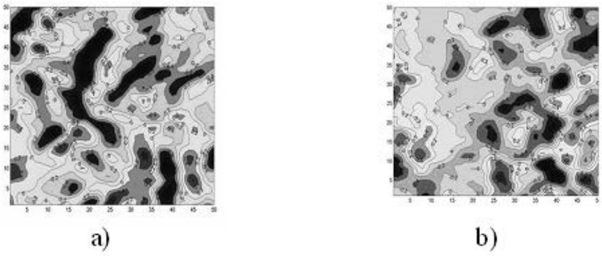


Fig. 16. Coordinate distributions of depolarization degree of TM lazer eradication: a - at mechanical asphyxia; b - at acute hemorrhage

We have also ascertained diagnostic possibilities of LP for forensic medical diagnostics of acute coronary insufficiency (ACI). Let us illustrate the results of investigations on the example of using the method of statistical matrix analysis.

Table 1

Statistical moments of the degree distribution in depolarization of TM lazer eradication at MA and AH

Statistical moments	Cause of death coming	
	asphyxia	**hemorrhage**
average	0,31 ± 0,027	0,24 ± 0,019
dispertion	0,18 ± 0,011	0,29 ± 0,021
asymmetry	7,14 ± 0,54	13,34 ± 0,11
excess	17,32 ± 0,174	9,25 ± 0,973

Fig. 17 illustrates results of experimental investigations of coordinate Z_{44}(m x n), and statistical h (Z_{44}) structure of Muller matrix phase elements Z_{44} of the native myocardial sections of the people under condition of ACI in comparison with the control group.

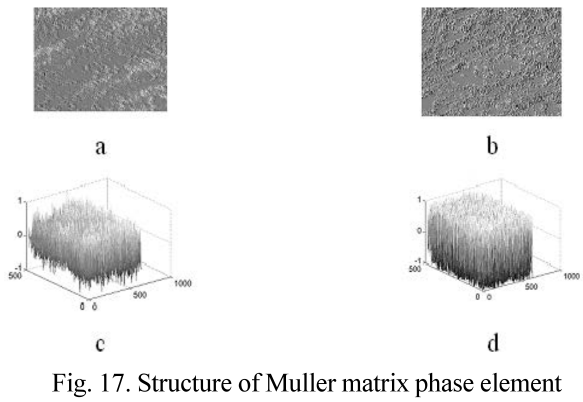


Fig. 17. Structure of Muller matrix phase element Z_{44}(m x n) of myocardium of people: a - coordinate structure in health; b - coordinate structure under conditions of ACI; c - statistical structure in health; d - statistical structure under conditions of ACI

Later on we investigated statistical structure of $N(Z_{44}=0)\equiv N_0$ and $N(Z_{44}=1)\equiv N_1$ dependence (Fig.17,18).

As a result of investigation of the dependences of quantitaty of extreme values $N(Z_{44}=1)\equiv N_1$ and $N(Z_{44}=0)\equiv N_0$ it has been revealed their substantial diagnostic sensitivity differentiation of cases of death coming

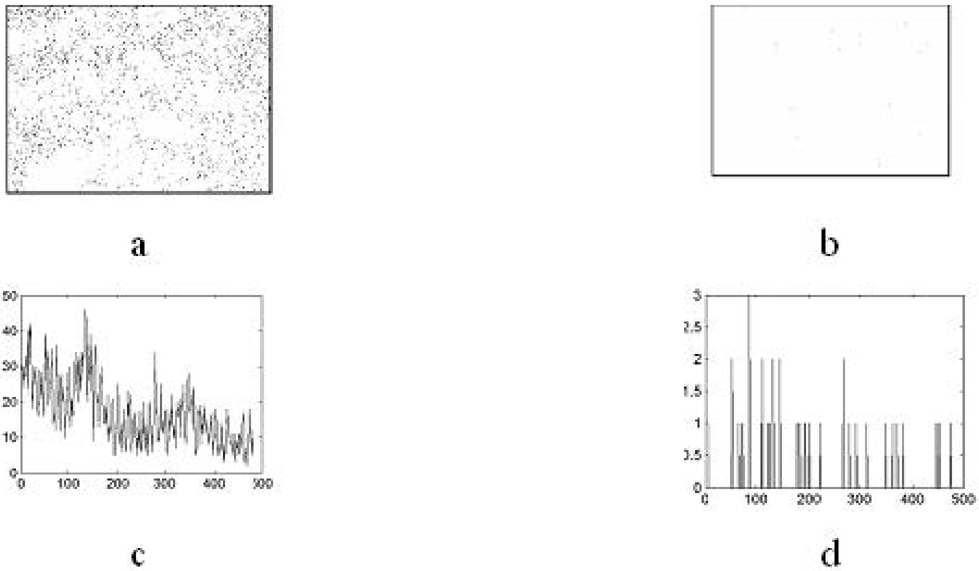


Fig. 18. Structure of dependences $N(Z_{44}=1)\equiv N_1$ phase elements Z_{44} of optic-isotrop component TM: a - coordinate structure in health; b - coordinate structure under conditions of ACI; c - quantitative structure in health; d - quantitative structure under conditions of ACI.

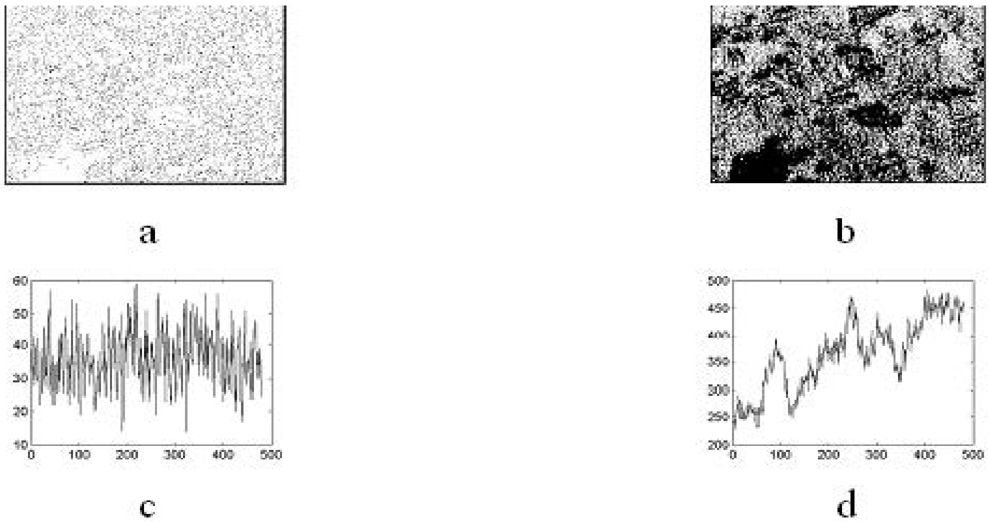


Fig. 19. Structural dependences $N(Z_{44}=0)\equiv N_0$ of the phase element Z_{44} of optic-isotroic constituent TM: a - coordinate structure in health; b- coordinate structure under conditions of ACI; c- quantitative structure in health; d- quantitative structure under conditions of ACI.

owing to ACI.

Quantity increase (on ane value order) of the extreme meanings Z_{44}=0 of Muller matrix phase element TM (fig. 18c, 18d) occur for ACI. The present fact is the evidence of substantially higher level of optic anisotropy of myosin fibrils in case of ACI in comparison with the standard.

Totality of statistical moments $M_{j=1;2;3;4}$ $(N_{0;1})$, describing dependences N_0 and N_1 (Table 2), characterize quantitatively the process of change of birefringence of the myocardium myosin fibrils at different extreme levels.

Statistical moments of the 3rd and 4th order of distributions $N_0(x)$ and $N_1(x)$ of the extreme meanings of phase elements Z_{44} of Muller matrix are the most informative. The following ranges of the distinctions between statistical parameters, that describe optically anisotropic constituent of the myocardium under conditions of ACI in comparison with the standard have been determined using the typical meaning Z_{44}: average $M_1(N_0)$ increased 5 times, dispersion $M_2(N_0)$ decreased 2, 3 times; asymmetry $M_3(N_0)$ decreased 9 times and excess $M_4(N_0)$ decreased 11 times.

The objective possibility of differentiation of the death coming cause and diagnostics of coronary insufficiency with the help of the method of statistical matrix analysis appear from the obtained data of experimental investigations of statistical structure of distributions of the quantity of the extreme meanings of phase element of Muller matrix in the myocardial tissue of both types.

Таблиця 2

Statistical moments of the 1-4th orders of distributions $N_0(x)$ and $N_1(x)$ of the extreme values of phase element Z_{44} of Muller matrix TM under conditions of ACI and in health

$M_j(N_0)$	Normal	ACI
$M_1(N_0)$	0,11 $\pm$ 0,026	0,74 $\pm$ 0,083
$M_2(N_0)$	0,46 $\pm$ 0,054	0,21 $\pm$ 0,033
$M_3(N_0)$	3,54 $\pm$ 0,56	0,43 $\pm$ 0,052
$M_4(N_0)$	6,21 $\pm$ 0,74	0,57 $\pm$ 0,72
$M_j(N_1)$	Normal	ACI
$M_1(N_1)$	0,32 $\pm$ 0,046	0,06 $\pm$ 0,007
$M_2(N_1)$	0,13 $\pm$ 0,044	0,61 $\pm$ 0,039
$M_3(N_1)$	0,84 $\pm$ 0,095	7,89 $\pm$ 0,96
$M_4(N_1)$	1,46 $\pm$ 0,18	9,43 $\pm$ 1,09

Conclusions

1.Laser polarimetry of hematomas of inner organs is effective for forensic medical determination of the time of their origin. Hematomas of different localization have coordinately inhomogeneous and individual structure on account of their multilayer arrangement structure. Utilization of indices of coordinate distributions of polarization conditions, degree of depolarization and phase displacements in laser images of hematomas in the internal organs is effective for the diagnostics of the prescription of their origin.

2.It has been detected that hour-long dynamics of morphological structure change of biological tissues in postmortem period is accompanied by the dynamic conformities in the structural changes of their polarization images, that is the reason to establish the prescription of death coming.

3.Complex use of the totality of polarizational, matrix, statistical and correlative methods of image analysis of histological sections of biological tissues affords an opportunity, depending of their type, to define the prescription of death coming during the period from 1 till 140 hours, at mistake of 1-1.5 hour.

4.It has been revealed the efficiency in determining hour intervals of the prescription of death coming at mechanical asphyxia for statistical moments of 1-4th orders of phase distribution from 1 till 36 hours ; for statistical moments 1-4th orders of distribution of depolarization degree from 1 hours till 74 hours, in case of death in consequence of hemorrhage for statistical moments of 1-4th orders of phase distribution from 1 to 48 hours; for statistical moments of 1-4th orders of distribution of depolarization degree from 1 hour to 92 hours, at mistake of 1 hour.

5.It has been determined and theoretically substantiated interdependencies between the formation of abrasions in life or after death and statistical (average and dispersion) and spatial frequency (dispersion of extremes Log-log dependences of spectra capacity) parameters, that characterize coordinate distributions of intensity, azimuths, elipticity, phase displacements between orthogonal components of laser wave in the images of a person's skin. Statistical criteria of differentiation of intravital or postmortem origin of abrasions of the body skin of a person's body (statistically significant difference for change of the average (M_1) from 1 to 130 hours, but for dispersion change (M_2) from 1 to 100 hours) have been revealed.

6.Investigations of statistical structure of quantitative distributions of the extreme meaning of Muller matrix phase element of myocardial tissue permit not only to diagnose acute coronary insufficiency, but to differentiate with other pathological conditions, when ordinary methods of histological research are not effective.

7.The most informative for diagnostics of acute ischemia of the myocardium is using statistical moments of 2-4th distribution orders $N_0(x)$ and $N_1(x)$ of extreme meanings of phase element Z_{44} of Muller matrix of myocardial tissue.

Perspectives of further investigations

The following perspective directions of the investigations have been revealed coming from the results obtained:

1)It is expedient to continue laser polarimetric study of a person's biotissue in case of change of the environment or influence of internal factor, to detect not only new specific indices and criteria, but to determine the most informative "target-organs" for the solution of the questions of medico-biological nature and decision of the questions (problems) of forensic medical practice;

2)Taking into account the significant optic activity, it will be expedient to extend the study of fluids and media of the cadavers for the detection of optic criteria typical for pathological processes and other conditions depending on the death reason;

3)To combine the results of all carried out investigations into the united data bank for making the basis for the conditions of the research and demonstrative availability of the forensic medical investigations in the departments of the regional beruau of higher quality.

Literature. 1.Бачинський В. Т. Лазерна спектрофотополяриметрія біологічних тканин людини в розробці об'єктивних критеріїв визначення давності настання смерті та часу утворення гематом : автореф. дис. на здобуття наук. ступеня докт. мед. наук: спец. 14.01.25 "Судова медицина" / В.Т. Бачинський. - Київ, 2009. - 35 с. 2.Бачинський В.Т. Моделювання оптичних властивостей гематом для діагностики давності їх виникнення /В.Т. Бачинський// Бук. мед. вісник. - 2008. - Т.12, №1. - С.173-176. 3.Бачинський В.Т. Поляризаційні образи позаклітинних матриць основних типів біологічних тканин для завдань судової медицини / В.Т. Бачинський // Клінічна та експериментальна патологія - 2008. - Т.7, №1. - С. 6-13. 4.Беженар І.Л. Судово-медична діагностика зажиттєвих та посмертних ушкоджень шкіри людини шляхом аналізу спектрів потужності інтенсивності її поляризаційних зображень /І.Л. Беженар// Український судово-медичний вісник. - 2007. - №1. - С.25-31. 5.Ванчуляк О.Я. Діагностика давності настання смерті методом лазерного поляриметричного моніторингу тканин людини: автореф. дис. на здобуття наук. ступеня канд. мед. наук: 14.01.25. / О.Я.Ванчуляк. - К.: НМАПО ім. П.Л.Шупика, 2007. - 20 с. 6.Ванчуляк О.Я. Метод поляризаційної візуалізації та статистичної обробки лазерних зображень архітектоніки паренхіматозних біотканин у діагностиці часу настання смерті / О.Я. Ванчуляк // Клінічна та експериментальна патологія. - 2005. - Т.4, №2. - С.105-110. 7.Ванчуляк О.Я. Можливості використання фрактального аналізу фазових лазерних зображень міокарда для діагностики гострої коронарної недостатності /О.Я. Ванчуляк// Клінічна та експериментальна патологія - 2011. - Т.10, №2 (36,ч1). - С. 9-12. 8.Дослідження статистичної структури деполяризації лазерного випромінювання тканиною печінки для диференціації настання смерті в результаті механічної асфіксії або крововтрати / В.Т. Бачинський, О.В. Павлюкович, В.Д. Мішалов, О.Я. Ванчуляк // Український медичний альманах - 2010 - Т.13, №1 - С.101-103. 9.Лазерна поляризаційна морфологія біологічних тканин: статистичний і фрактальний підходи. Монографія / О.Г. Ушенко, В.П. Пішак, О.В. Ангельський, Ю.О. Ушенко. - Чернівці: Колір-Друк, 2007. - С. 314. 10.Основи лазерної поляриметрії: Патоморфологічні зміни біологічних тканин / О.Г. Ушенко, В.Т. Бачинський, О.Я. Ванчуляк, І.Л. Беженар // - Чернівці: Чернівецький нац. ун-т, 2010. - 372 с. 11.Bachinskiy V.T. Polarization properties of biological rough surfaces / V.T. Bachinskiy, Yu.A. Ushenko // Proc. SPIE. - 2008. - 797363. 12.Optical Measurements: Polarization and Coherence of Light Fields / O.V. Angelsky, V.T. Bachinskiy, T.M. Boichuk, A.G. Ushenko [et all.] // in the book "Modern Metrology Concerns" edited by Luigi Cocco - ISBN 978-953-51-0584-8 - InTech, May 5, 2012 - 469p; P. 263-316. 13.Temporal spectral change of the degree of depolarization of laser radiation scattered by the hepatic tissue to diagnose the prescription of death coming /V.T. Bachins'kyi, O.V. Pavliukovych, O.Ya. Wanchuliak, I.H. Savka //Буковинський медичний вісник. - 2010. - Т.14, №4 (56). - С.119-121.

ЛАЗЕРНО-ПОРЛЯРИМЕТРИЧЕСКИЕ МЕТОДЫ ИССЛЕДОВАНИЯ БИОЛОГИЧЕСКИХ ТКАНЕЙ В СУДЕБНОЙ МЕДИЦИНЕ - ПЕРСПЕКТИВЫ, РЕАЛИИ И БУДУЩЕЕ

В.Т. Бачинский, Т.Н. Бойчук, О.Я.Ванчуляк, А.Г.Ушенко

Резюме. К концу XX века разграничение научных исследований на узкие дисциплинарные направления исчерпало свой потенциал и стало бесперспективным, поэтому общемировой тенденцией является междисциплинарная интеграция для разработки принципиально новых критериев, которые бы позволили решить сложные медико-биологические задачи. Авторы, объединив интеллектуальные достижения в области судебно-медицинской экспертизы и оптической физики, разработали новые судебно-медицинские методы диагностики и объективные критерии для решения вопросов судебно-медицинской науки и практики, в частности установление давности наступления смерти при различных ее видах, времени формирования гематом, прижизненности образования телесных повреждений, диагностики острой ишемии миокарда.

Ключевые слова: лазерная поляриметрия, давность наступления смерти, формировании гематом, прижизненность, острая ишемия миокарда.

ЛАЗЕРНО-ПОРЛЯРИМЕТРИЧНІ МЕТОДИ ДОСЛІДЖЕННЯ БІОЛОГІЧНИХ ТКАНИНИ У СУДОВІЙ МЕДИЦИНІ - ПЕРСПЕКТИВИ, РЕАЛІЇ ТА МАЙБУТНЄ

В.Т. Бачинський, Т.М. Бойчук, О.Я. Ванчуляк О.Г.Ушенко

Резюме. До кінця XX століття розмежування наукових досліджень на вузькі дисциплінарні напрямки вичерпало свій потенціал та стало безперспективним, тому загальносвітовою тенденцією є міждисциплінарна інтеграція для розробки принципово новітніх критеріїв, які б дозволили вирішити складні медико-біологічні завдання. Автори, об'єднавши інтелектуальні здобутки в галузі судово-медичної експертизи та оптичної фізики, розробили нові судово-медичні методи діагностики та об'єктивні критерії для вирішення питань судово-медичної науки та практики, зокрема встановлення давності настання смерті при різних її видах, часу формування гематом, зажиттєвості утворення тілесних ушкоджень, діагностики гострої ішемії міокарда.

Ключові слова: лазерна поляриметрія, давність настання смерті, час формування гематом, прижиттєвість, гостра ішемія міокарда.

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