RS Global

ISSN 2413-1032

WORLD SCIENCE

Multidisciplinary Scientific Edition

WORLD SCIENCE

№ 2(63)
February 2021

DOI: https://doi.org/10.31435/rsglobal_ws

Publisher –
RS Global Sp. z O.O.,

Warsaw, Poland

Numer KRS: 0000672864
REGON: 367026200
NIP: 5213776394

Publisher Office's address:
Dolna 17, lok. A_02
Warsaw, Poland,
00-773

Website: https://rsglobal.pl/
E-mail: editorial_office@rsglobal.pl
Tel: +4(822) 602 27 03

DOI: 10.31435/rsglobal_ws
OCLC Number: 1051262033
Publisher - RS Global Sp. z O.O.
Country – Poland
Format: Print and Electronic version
Frequency: monthly
Content type: Academic/Scholarly

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MEDICINE

A DIFFERENTIATED APPROACH TO INFUSION-TRANSFUSION THERAPY FOR LARGE BLOOD LOSS IN PATIENTS WITH POLYTRAUMA

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7437

ARTICLE INFO

Received: 26 November 2020
Accepted: 05 February 2021
Published: 28 February 2021

KEYWORDS

polytrauma, blood loss, oxygen transport system, postoperative period.

ABSTRACT

With polytrauma, more than 30% of victims are diagnosed with severe blood loss, grade III MARINO of the leading components is transfusion therapy, which aims to restore the erythron system and improve the functional state of the oxygen transport system. The addition to intensive care of substances that affect lipid peroxidation and energy status of cells can reduce the number of heterogeneous transfusions and thus reduce the number of complications in the postoperative period. Such substances may be a solution of ceruloplasmin with a leading antioxidant effect and a solution of D-fructose-1,6-diphosphate sodium salt of the hydrate with an energetic effect. Criteria for exposure to these substances should be indicators such as blood levels of hemoglobin, phosphorus, malonic dialdehyde and lactate / pyruvate ratio.

Citation: Tyhai Yuliia, Mykhnevych Kostiantyn. (2021) A Differentiated Approach to Infusion-Transfusion Therapy for Large Blood Loss in Patients with Polytrauma. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7437

Introduction. Analysis of injuries in recent years has shown a significant (3 times) increase in the number of victims with combined trauma complicated by shock with blood loss [1, 2]. Mortality in this group of victims reaches 68-90% [3, 4]. One of the leading conditions in providing emergency care to victims with combined chest and abdominal trauma with polytrauma is intensive care, the focus and significance of which depends on the timely diagnosis of the severity of the victim, volume, degree and rate of blood loss [5]. Despite the significant progress made in recent decades in compensating for acute massive blood loss and prevention of possible postoperative complications, mortality from it remains quite high and varies from 30 to 90% [6, 7].

Tactics of perioperative infusion-transfusion therapy is based on clinical assessment of blood loss, mean blood pressure, heart rate, hemoglobin, hematocrit, acid-base parameters and blood gases and other parameters [8]. The analysis of the depth of changes in these indicators, central hemodynamics, parameters of cellular, humoral and gas systems of the body, oxygen transport function of the blood and peripheral circulation are very important in the acute period of blood loss. With adequate infusion-transfusion therapy, primarily with the possibility of reinfusion, the clinical condition of patients improves from the first day of stay in the intensive care unit [9, 10].

Today, there are many algorithms for the correction of blood loss in various clinical situations, including patients with polytrauma. However, the issues of metabolic adaptation of circulating

erythron in response to different options for the introduction of hemo- and plasma correctors are still unresolved. This is why the issues of intensive care of blood loss, including patients with polytrauma, need detailed study and scientific substantiation, followed by the provision of recommendations for examination, intensive care and intensive care.

The aim of the study was to increase the effectiveness of treatment of patients with polytrauma with hemorrhagic shock through the development and implementation of a differentiated approach to infusion and transfusion therapy based on the clarification of the mechanisms of systemic oxygen transport in the postoperative period

Materials and methods. This study is based on the analysis of the results of a comprehensive clinical-instrumental and laboratory dynamic study of hemodynamic, biochemical in 96 patients with polytrauma who were treated at the polytrauma department and intensive care unit for patients with combined trauma in Kharkiv City Clinical Emergency Hospital in the period 2017 - 2020, which evaluated the effectiveness of the proposed treatments in the process of cohort prospective randomized simple open-label clinical trial. The conditions for selecting patients for the study were age up to 60 years, the presence of polytrauma, the possibility of productive contact with the patient at admission (14-15 points for GCG), obtaining informed consent, compensation at the time of injury of any comorbidities, no history blood, cancer, severe heredity, alcoholism, mental disorders, allergic reactions, blood transfusions, the use of immunocorrectors, glucocorticoids.

Criteria for non-inclusion were age over 60 years, the presence of damage to the craniofacial anatomical and functional area, as well as abdominal organs, musculoskeletal system on the severity scale (AIS), which belonged to the category of "critical injury, survival is unlikely", the presence of post-traumatic heart attack.

In order to stratify patients, the severity of the injury was taken into account according to the ISS scale (Injury Severity Score) − all patients had 9-24 (medium severity) points, its combination, mechanogenesis, concomitant somatic pathology, time since injury, anesthesia and surgery. All victims at the time of admission had a deficit of circulating blood volume (BCV) of III degree according to MARINO (1998) − 30-40%. BCV deficit was calculated with the formula: BCV def. = BCV p.-BCC f., where BCCp. − proper BCC (for women 60 ml / kg, for men 70 ml / kg, pregnant and overweight 75 ml / kg); BCV f. − actual BCV = body weight, kg / part by weight of Ht (hemoglobin). All patients during the operation, against the background of diuresis control as a component of infusion-transfusion therapy were transfused 1 dose − 450 ± 45 ml − donor erythrocytes to maintain normal oxygen transport function of the blood in the postoperative period.

The selection of patients was carried out in accordance with the goal and objectives.

After the analysis of the obtained indicators at the screening stage against the background of no probable difference between the figures of the obtained indicators in each of the groups − the number of points and the APACHE II scale averaged 13.1 ± 1.6 points − we combined all data and took the average values with the interval min-max.

To implement the study and study the impact of a differentiated approach to the correction of blood loss on the consequences of the course of patients with traumatic disease, patients were divided into 3 randomized groups: group 1, 26 patients (16 men, 10 women) with mean age 47.7 ± 4.6 years, time from the moment of injury 2.02 ± 0.47 hours; group 2 − 32 people (20 men, 12 women) with average figures of age 48.1 ± 3.8 years, time from injury 2.01 ± 0.61 hours, who were additionally prescribed D-fructose-1.6 -disophate sodium salt hydrate 150 mg / kg 2 times a day intravenously at a rate of 10 ml per minute for 14 days; group 3 − 34 persons (20 men, 14 women) with average age of 47.1 ± 3.9 years, time from injury 2.06 ± 0.42 hours, who in addition to the developed algorithm of intensive care was prescribed a solution of ceruloplasmin in a daily dosage of 5 mg / kg, diluted in 200 ml of 0.9% sodium chloride solution at a rate of 30 drops per minute intravenously for 14 days in patients with polytrauma with heavy blood loss.

Given the fundamental differences in pharmacodynamics and pharmacokinetics of additionally prescribed substances for the functional state of the oxygen transport system in patients with massive blood loss in the postoperative period, it was important to control the number of repeated blood transfusions to achieve a satisfactory state of homeostasis in patients. 3 and 10 days of the postoperative period were selected as control points: the state of erythrocyte metabolism was determined by monitoring the level of hemoglobin, phosphorus, malonic dialdehyde in the blood of patients, and the lactate / pyruvate ratio was determined. Methods of parametric statistics were used to process the obtained data. Statistical processing of data that were entered into Excel spreadsheets was performed. The significance of the obtained data was checked using Student's t-test (for n <100) at a

given level of reliability p = 0.95. To be able to use the Student's t test, the Fischer-Snedekor test was calculated − the ratio of the larger variance to the smaller. All mathematical operations and graphical constructions were performed using the software packages "Microsoft Office XP": "Microsoft XP Home" and "Microsoft Excel XP" on a personal computer.

Results of the research. Since the transfusion of donor erythrocytes is aimed at restoring the volume of circulating erythrocytes and maintaining normal oxygen transport function of the blood, clinically it reproduces a decrease in shortness of breath, tachycardia, increased hemoglobin in the blood. The effectiveness of the erythrocyte transfusion procedure depends on the initial parameters of the hemoglobin level, the presence or absence of cessation of bleeding, the hematocrit of the transfusion medium and its shelf life.

Given that the decrease in physical and muscular activity is accompanied by a decrease in the body's need for oxygen, against this background, excessive desire to quickly restore hemoglobin levels can lead to the development of cardiovascular failure and increase thrombogenic hazard.i Especially dangerous is the desire in case of hemorrhagic shock. very often accompanied by the development of intravascular coagulation syndrome. Erythrocyte transfusion always exacerbates this syndrome in such situations.

Since there are no absolute indications for heterologous blood transfusion, and the severity of the patient's bleeding does not depend on the level of hemoglobin and hematocrit, it is important to differentiate the approach to infusion and transfusion therapy in victims with polytrauma with heavy blood loss.

When performing a statistical analysis of hemoglobin in the blood, the number of blood transfusions with a single dose (450 ± 45 ml) of erythrocyte mass in order to maintain the functional state of the oxygen transport system at a satisfactory level in patients groups 1, 2 and 3 at the time of admission (table 1), 3-th (table 2) and the 10th day (table 3) of intensive care, the data were obtained, which are presented in table 1.

Table 1.

Indicators	Group 1 (26 patients)	Group 2 (32 patients)	Group 3 (34 patients)
Hemoglobin, g / l	92,7±8,1	87,4±9,6	90,9±7,2
Number of heterogeneous blood transfusions	1,2±0,4	1,1±0,2	1,1±0,1
Phosphorus, mmol / l	1,06±0,22	1,07±0,19	1,06±0,17
Malonic dialdehyde, μmol / l	1,24±0,08	1,21±1,1	1,22±1,1
Lactate / pyruvate	122,4±14,1	126,1±12,9	122,8±10,6

Table 2.

Indicators	Group 1 (26 patients)	Group 2 (32 patients)	Group 3 (34 patients)
Hemoglobin, g / l	92,7±8,1	87,4±9,6	90,9±7,2
Number of heterogeneous blood transfusions	3,2±0,6	1,9±0,4*	2,1±0,2**
Phosphorus, mmol / l	0,78±0,04	0,82±0,01	1,02±0,04**°
Malonic dialdehyde, μmol / l	1,09±0,02	0,62±0,01	1,02±0,02°
Lactate / pyruvate	76,2±10,4	45,8,1±16,9*	54,2±7,4**

* - p<0,05 – probable difference between groups 1 and 2;
**- p<0,05 – probable difference between groups 2 and 3;
° - p<0,05 – probable difference between groups 1 and 3.

Table 3.

Indicators	Group 1 (26 patients)	Group 2 (32 patients)	Group 3 (34 patients)
Hemoglobin, g / l	112,6±4,7	109,2±5,2	111,4±3,9
Number of heterogeneous blood transfusions	3,2±0,8	1,9±0,6*	2,1±0,4**
Phosphorus, mmol / l	1,04±0,24	1,02±0,17	1,37±0,02**
Malonic dialdehyde, μmol / l	0,92±0,16	0,22±0,07*	0,76±0,19°
Lactate / pyruvate	42,7±7,2	37,8±6,4	18,6±2,9**°

* - p<0,05 – probable difference between groups 1 and 2;
**- p<0,05 – probable difference between groups 2 and 3;
° - p<0,05 – probable difference between groups 1 and 3.

Statistical analysis revealed that at the time of admission, all groups of patients were randomized for hemoglobin, phosphorus, malonic dialdehyde in the blood, lactate / pyruvate ratio and the number of heterogeneous blood transfusions performed during surgery. Subsequently, on the 3rd day of intensive care, patients in group 2 had a minimum number of blood transfusions, 1.9 ± 0.4, which were performed to achieve the target level of hemoglobin in the blood as a leading component of the oxygen transport system. With. Also, these patients had a minimum level of malonic dialdehyde in the blood and the ratio of lactate / pyruvate, which indicated a minimal effect of anaerobic processes on the course of traumatic disease. Finding the level of phosphorus at the minimum allowable reference level, 0.82 ± 0.01 mmol / l, also indicated a satisfactory condition of the erythron system and blood buffers.

On the 10th day of intensive care there was a tendency of the predominant effect of differentiated infusion-transfusion therapy in patients of group 2 on the general state of homeostasis. Thus, patients in group 2 had significantly fewer heterogeneous blood transfusions, which meant the leading pathogenetic mechanism of complications in patients with polytrauma with massive blood loss. Although on the 10th day of treatment, lactate / pyruvate ratios were best in group 3 patients, and in group 2 patients they were also within the reference range. Given that the decisive factor in the results of the study was the number of heterogeneous blood transfusions, which were necessary to maintain homeostasis in patients with polytrauma with blood loss of III degree according to MARINO, the appointment of ceruloplasmin solution with leading antioxidant action was not the most period of traumatic illness in these patients.

Conclusions. Developed and implemented an algorithm for infusion and transfusion therapy in the perioperative period in patients with massive blood loss in polytrauma, which are prescribed to: influence the process of lipid peroxidation − additional introduction of ceruloplasmin solution in a daily dosage of 5 mg / kg, diluted in 200 mg % sodium chloride solution at a rate of 30 drops per minute intravenously for 14 days − allowed to minimize the number of heterogeneous blood transfusions and, in turn, the number of complications in the postoperative period.

Developed and implemented an algorithm for infusion and transfusion therapy in the perioperative period in patients with massive blood loss in polytrauma, which are prescribed to: influence the process of energy metabolism, including erythrocytes − additional introduction of a solution of D-fructose-1,6-diphosphate sodium salt hydrate 150 mg / kg 2 times a day intravenously at a rate of 10 ml per minute for 14 days − allowed to improve the systemic rate of systemic oxygen transport by accelerating the recovery of aerobic metabolism in tissues.

The study of the effect of the combination in the composition of infusion-transfusion therapy as a differentiated approach of ceruloplasmin solution and solution of D-fructose-1,6-diphosphate sodium salt of hydrate as substances that have fundamentally different mechanisms of action, but may reduce the transfusion of heterogeneous and heterogeneous compounds is promising. the course of traumatic illness.

Conflict of interest. The authors do not declare a conflict of interest.

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OPTIMIZATION OF INTENSIVE THERAPY IN PATIENTS IN THE ACUTE PERIOD OF COMA

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7438

ARTICLE INFO

Received: 29 November 2020
Accepted: 05 February 2021
Published: 28 February 2021

KEYWORDS

neurotropic or vasotropic mechanism, succinic acid, D-fructose-1,6-diphosphate sodium salt hydrate.

ABSTRACT

When prescribing intensive care to an unconscious patient, it is important to determine the etiological factor of the critical condition. The distribution of patients by neurotropic or vasotropic mechanism of disturbance of consciousness is extremely important for successful treatment and prevention of complications. Determination of autoantibodies to brain tissue is an important diagnostic criterion for the adequacy of intensive care. Administration of substances with succinic acid and D-fructose-1,6-diphosphate sodium salt hydrate is pathogenetically determined in this category of patients.

Citation: Deineko Maksym, Volkova Yuliya. (2021) Optimization of Intensive Therapy in Patients in the Acute Period of Coma. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7438

Introduction. Coma is one of the most common disorders of consciousness. It was found that about 3% of visits to intensive care units of city hospitals are states accompanied by loss of consciousness. The importance of this class of neurological disorders determines the need for a systematic approach to their diagnosis and treatment [1, 2].

The increased capabilities of computed tomography led to a not entirely justified turn of diagnostic measures in coma towards lesions detected by computed tomography (for example, hemorrhages, tumors, hydrocephalus). This approach, at times advisable, is sometimes unreasonable, since in most cases the coma is of toxic or metabolic origin [3].

The tactics of patient management should be conditioned by the knowledge of the pathological nature of the diseases that cause coma. The normal level of consciousness (wakefulness) depends on the activating effect on the cerebral hemispheres from the groups of neurons located in the reticular formation of the brain stem. To ensure a normal level of consciousness, the integrity of the cerebral hemispheres, the reticular formation and their connections is necessary [4, 5]. Consequently, the main causes of coma are bilateral lesions of the cerebral hemispheres or inhibition of their activity by drugs and other drugs or toxins; brain stem lesions or metabolic disorders that damage or inhibit the reticular formation [6].

There are observations that large unilateral lesions of the cerebral hemispheres, especially the left, can cause drowsiness (but not to whom) even in the absence of damage to the opposite hemisphere and reticular formation [7].

The pathophysiological bases of coma are either mechanical destruction of vital parts of the brain stem or cerebral cortex (organic coma), or a global violation of metabolic processes in the brain (metabolic coma). A coma of metabolic origin can occur due to the cessation of delivery of energy substances (hypoxia, ischemia, hypoglycemia) or damage to the neurophysiological reactions of neuronal membranes (drug or alcohol intoxication, epilepsy, or acute traumatic brain injury) [8].

Brain activity depends on the continuity of blood flow and delivery of oxygen and glucose, which are consumed at a rate of 3.5 ml / 100 g per minute and 5 ml / 100 g per minute, respectively. The stores of

glucose in the brain are able to provide energy metabolism for about 2 minutes after stopping the blood flow, although loss of consciousness occurs within 8-10 seconds. When hypoxia occurs simultaneously with ischemia, the available glucose supply is depleted even faster. Normal cerebral blood flow at rest is approximately 75 ml / 100 g per minute in gray matter and 30 ml / 100 g per minute in white matter (average 55 ml / 100 g per minute). This level of blood flow provides an adequate metabolism with a moderate safety factor to accommodate most physiological changes. With a decrease in cerebral blood flow to 25 ml / 100 g per minute, a slow rhythm appears on the electroencephalogram (typical for metabolic encephalopathy), and at 15 ml / 100 g per minute, the electrical activity of the brain stops [9].

Even if all other functions, such as temperature and blood oxygen saturation, remain within normal limits, a decrease in cerebral blood flow below 10 ml / 100 g per minute causes irreversible changes in the brain.

Electroencephalography provides important data on the general electrophysiological state of the cerebral cortex, and the presence of asymmetry may indicate a unilateral lesion that is not visualized by CT examination [10].

In most cases, coma is part of a known pathological process, such as hypoxia, stroke, trauma, hepatic or renal failure, and reactions to various medications and other medications. In this case, the main attention should be paid to the primary disease.

It is important to remember some general rules: the causes of acute sudden coma are most often the intake of various drugs or traumatic brain damage - hemorrhage, trauma or hypoxia; subacute development is usually due to previous therapeutic or neurological conditions, including secondary cerebral edema, occurring around a pre-existing lesion [11, 12]. Thus, it can be concluded that the existing etiological classifications of coma are not convenient for use in an intensive care situation and only complicate the choice of the optimal tactics for conducting intensive therapy.

By the method of advancing the results of the treatment of ailments in the state of the comatose period, with the help of preventive measures, the accelerated methods of intensive therapy will be improved.

Materials and methods.

There are 122 patients, who were on the basis of the intensive therapy of the Kharkiv hospital of non-removable benches during the period from 2017 to 2020. Among them there are 40 patients, group I, bully spilled according to the protocol adopted by the protocol of the ill person at the state period comatose. There were also 82 patients: 40 - of them with the so-called neurotropic start (toxic accent, yes, the primary accent - the primary toxicity of the cells of the central nervous system) - group II, 42 patients - with the vasotropic start (primary in the brain) - group III.

When divided into groups, we used the primary cause of the pathological condition - the absence of consciousness - in order to introduce in its acute period of additional substances with a fundamentally pathogenetically directed action.

Therefore, patients of group II were considered to be those in whom the primary was a toxic lesion of cells of the central nervous system with global metabolic disorders in the brain, in which there was a chemical inhibitory effect on the central nervous system with inhibition of metabolic and electrical activity of cell membranes. and in the bark. In addition to these patients, neurotropic drugs (nootropics) and antihypoxants (succinic acid) were added to the intensive care unit.

In turn, patients of group III were considered those in whom the process of primary destruction of brain structures was caused by blood spilled, or lack of its receipt, transmineralization or "sick cell syndrome", when the cells are rapidly excreted K, impaired excretion of Na (requiring energy expenditure that becomes deficient due to lack of oxygen.) Decreased intracellular ATP concentration enhances the normal function of the K-Na pump. These patients in the acute period of coma were additionally prescribed vasotron drugs (vascular wall protectors / disaggregants) – D-fructose-1,6-diphosphate sodium salt hydrate.

Material and methods. To confirm the adequacy of randomization of patients in group I, groups I and II, we used rating scales and instrumental methods.

Therefore, to assess the most important physiological systems in patients of the department, we used the method of Tarasov DG et al. (2017): in all patients, blood was taken daily to assess the severity to determine the indicators of the general blood test, including the calculation of the leukocyte formula, from the peripheral vein to the blood collection system with anticoagulant K2 EDTA. 30 minutes after blood collection, a peripheral blood smear was prepared and stained according to

Romanovsky. After staining blood smears by immersion microscopy, the leukocyte formula was determined. When detecting normoblasts in a blood smear, their number per 100 leukocytes was counted: when their number ranged from 1 to 6 per 100 leukocytes, the severity of the condition was assessed as moderate; when the number of normoblasts in the range from 7 to 20 per 100 leukocytes evaluated the severity of the condition as severe; with an increase in the number of normoblasts more than 21 per 100 leukocytes evaluated the severity of the condition as extremely severe.

To study the autoimmune response, the levels of autoantibodies to brain antigens in the serum were determined by ELISA on the day of admission, on the 3rd, 7th and 14th day of treatment.

Preparation of the studied biological material: blood for the study was taken from peripheral or central veins. Blood was centrifuged for 10 minutes at 2000 g. 1.5 ml of serum was frozen at -20°C and stored until the study. A total of 590 serum samples from patients with surgical aortic pathology were prepared for the study. To perform the study, the serum was thawed once at room temperature.

The determination of autoimmune antibodies was performed to assess the severity of brain tissue damage as the leading markers of disease prognosis.

Methods of parametric statistics were used to process the obtained data. Statistical processing of data that were entered into Excel spreadsheets was performed. The significance of the obtained data was checked using Student's t-test (for n <100) at a given level of reliability p = 0.95. To be able to use the Student's t test, the Fischer-Snedekor test was calculated − the ratio of the larger variance to the smaller. All mathematical operations and graphical constructions were performed using the software packages "Microsoft Office XP": "Microsoft XP Home" and "Microsoft Excel XP" on a personal computer.

Results of the research.

For the assessment of the young inflow of ailments on the prognosis of illnesses at all points of control - appropriate, 3rd, 7th and 14th, and for the addition - the method of Tarasov D.G. was used, de criteria of the severity of the patients of blood problems in the norm (table 1).

Table 1. The severity of the condition of patients in groups I, II and III (according to the method of Tarasov D.G., 2017)

Point of control	Group I n = 40	Group II n = 40	Group III n = 42
	Number of normoblasts		
Admission to the clinic	2,7±1,1	2,9±1,2	2,9±1,4
3rd day	4,2±1,7	3,9±1,9	4,1±1,6
7th day	2,9±1,2	2,7±1,9	2,9±1,4
14th day	1,8±0,6	1,6±0,9	1,8±0,7

Note: p > 0,05

From table 1 it can be seen that in all studied patients at all stages of the study − control points − the general condition was regarded as moderate, which confirmed the finding of the total number of normoblasts in a blood smear per 100 leukocytes in the range from 1 to 6. Which was evaluated clinically, depended in all patients solely on the functional state of brain tissue. In this case, an important point was the determination of autoimmune antibodies.

First, we determined autoimmune antibodies in all patients at the time of admission (table 2). Given the absence of probable differences between the groups in terms of autoantibody numbers to brain antigens, we calculated their average score between the groups and took it as the starting level of comparison.

Table 2. Indicators of neurospecific proteins in groups I, II and III in patients in the acute period of coma

Autoantibodies to brain antigens	Group I n = 40	Group II n = 40	Group III n = 42	Average starting level
The main protein is myelin	32,1±2,2	32,9±2,1	33,1±1,9	32,7±2,06
Calcium-binding protein S-100	11,4±0,6	12,1±0,9	11,9±0,7	11,8±0,7
Neurospecific enolase	26,1±2,2	27,2±1,9	26,2±2,1	26,5±2,06
Total human brain antigen	32,1±1,7	32,2±1,8	32,4±1,9	32,2±1,8

Note: p > 0,05

It is known that the destruction of myelin is a universal mechanism of response of nervous tissue to damage. When the central nervous system is damaged, the function of the blood-brain barrier is disturbed, which is accompanied by an increase in the concentration of neurospecific proteins in the serum. The dynamics of their numbers in the blood has a proportional effect on the prognosis of the disease. Given the principle of grouping patients, it is important to observe the dynamics of neurospecific antibodies in all studied patients (table 3).

Table 3. Indicators of neurospecific proteins in groups I, II and III in patients in the acute period of coma

Autoantibodies to brain antigens	Group I n = 40	Group II n = 40	Group III n = 42
To the main protein of myelin, average starting level: 32,7±1,06			
3rd day	37,4±2,2×	32,9±0,1*	33,1±1,9**
7th day	36,1±1,6×	33,1±0,4*	33,4±0,7**
14th day	34,8±1,1	32,7±0,2*	32,9±0,4**
To the S-100 protein, average starting level: 11,8±0,4			
3rd day	15,6±1,2×	12,4±0,7*	12,6±0,6**
7th day	14,4±1,1×	12,2±0,8*	12,4±0,2**
14th day	13,7±1,2×	12,2±0,8	12,2±0,8
To neurospecific enolase, average starting level: 26,5±2,06			
3rd day	36,4±2,4×	29,2±1,9*	29,2±2,1**
7th day	34,7±1,6×	27,4±0,8*	28,2±1,1**
14th day	32,9±1,2×	26,8±0,68	26,9±0,9**
To the total human brain antigen, average starting level: 32,2±1,8			
3rd day	37,4±2,6×	34,2±2,7	32,4±1,9**
7th day	41,2±2,9×	35,6±0,8*	35,2±1,4**
14th day	38,1±1,8×	34,7±0,4*	34,8±0,9**

Note: * p <0,05 − indicator between groups I and II; ** p <0,05 − indicator between groups I and III; × p <0,05 − the indicator between group I and the average starting level of the indicator.

During the statistical analysis of the dynamics of autoantibodies to brain antigens, a significant positive effect of the therapy prescribed in groups II and III pathogenetically aimed at the primary etiological factor was determined. Thus, the main protein of myelin on the 3rd day of treatment in patients of group I was probably p <0.05, higher than the average starting level and was 37.2 ± 2.2. It was also probably p <0.05, higher than its figures in patients of groups II and III, where it was 32.9 ± 0.1 and 33.1 ± 1.0, respectively. On the 7th day of observation, the dynamics of this indicator was identical. After 2 weeks of treatment in patients of group I the level of autoantibodies to the main protein of myelin was not likely to exceed the average starting level, was 34.8 ± 1.1, but was probably p <0.05, higher than in groups II and III, 32.7 ± 0.2 and 32.9 ± 0.4, respectively.

When determining the dynamics in the blood of autoantibodies to the protein S-100 it was found that on the 3rd day of treatment in patients of group I their level was 15.6 ± 1.2, probably p <0,05, exceeded the average starting level, and also figures in groups II and III, where it was 12.4 ± 0.7 and 12.6 ± 0.6, respectively. In the future, this trend was maintained and only on the 14th day of treatment, the probable difference between the groups disappeared. However, the level of this indicator after 2 weeks of hospital stay in patients of group I remained probably p <0.05, higher than at the start, which indicated the possibility of long-term consequences in these patients.

The same dynamics was observed in the analysis of autoantibodies to neurospecific enolase and total human brain antigen, which can be seen in table 2.

Given the above results, it can be argued that the distribution of patients with coma at the stage of screening by etiological factor in order to assign the appropriate pathogenetically oriented component to the existing protocol of intensive care is an important mechanism for preventing long-term consequences and disease in general.

Conclusions. Being the triggering mechanism of the pathogenesis of coma development, the etiological factor is not always decisive in mortality

Therefore, the features of pathogenetic disorders and the level of control of their changes acquire a major role in the outcome of the disease.

One of the decisive moments in the prognosis of coma as a pathological condition is its acute period, which requires the identification of an integrative indicator in the priority prescription of drugs with one or another pharmacodynamics in addition to the main protocol.

The key point of the possibility of improving the prognosis in coma of any genesis is the achievement of the perfusion-metabolic balance, which depends on the timely determination of the dominant disorders (perfusion - metabolic) and the appointment of specific therapy from the first minutes of contact with the patient, even at the diagnostic stage.

Conflict of interest. The authors do not declare a conflict of interest.

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THE ROLE OF THE FUNCTIONAL CONDITION OF ERYTHROCYTES IN DETERMINING THE PROGNOSIS IN PATIENTS WITH BURN INJURY

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7439

ARTICLE INFO

Received: 04 December 2020
Accepted: 12 February 2021
Published: 28 February 2021

KEYWORDS

burn injury, hemolysis, oxidative stress, ceruloplasmin, D-fructose-1,6-diphosphate sodium salt hydrate.

ABSTRACT

In the event of a burn injury, one of the leading pathogenetic mechanisms of complications is intravascular hemolysis of erythrocytes. Oxidative stress is the initiating factor in the development of hemolysis. The appointment of ceruloplasmin solution is pathogenetically directed at clinical signs of burn shock. Its appointment during a 10-day stay in the clinic is an important component of the intensive care unit. Determining the indices of the functional state and architecture of erythrocytes is an important component of the diagnostic program for peak trauma.

Citation: Fadieiev Pavlo, Gryshchenko Alona. (2021) The Role of the Functional Condition of Erythrocytes in Determining the Prognosis in Patients with Burn Injury. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7439

Introduction. Changes in the structure and function of erythrocytes play an important role in the development of hypoxia, so the study of human [1, 2].

One of the main biophysical indicators of blood is its rheological properties. Blood rheology − fluidity, determined by the totality of the functional state of the formed elements (mobility, deformability, aggregation activity of erythrocytes, leukocytes and platelets), viscosity (concentration of proteins and lipids) and osmolarity of blood. The microcirculatory section of the vascular system is the place where the greatest resistance to blood flow is manifested [3, 4]. The key role in the formation of the rheological parameters of blood belongs to uniform elements, primarily erythrocytes, which make up 98% of the total cell population [5] and, according to the experimental data of VD Malyshev, AP Pleskova (1994), determine the fluidity of blood at the level of microvessels − in the zone where gas exchange takes place [6, 7]. The transport of substances through the erythrocyte membrane is carried out, depending on their chemical properties, in several ways: by diffusion through lipid regions, or by carrier proteins embedded in the membrane [8, 9]. The erythrocyte membrane is easily permeable to gases and anions. Some enzymes are adsorbed and transported on the membrane surface [10]. The erythrocyte membrane is not permeable to glucose, urea, potassium and sodium cations and is impermeable to proteins. Membrane ion pumps provide active transport of sodium ions and glucose molecules [11].

Of particular scientific interest is the state of erythrocytes, which are responsible, first of all, for the transport of oxygen in critical conditions of the body, when there is a threat of occurrence or is already developing hypoxia. With the onset and progression of various diseases, as well as in critical conditions, injuries accompanied by severe tissue damage, the water-electrolyte composition of the blood is disturbed [12, 13] and, as a consequence, the functioning of the blood corpuscles is impaired. There is a violation of one of the most important biophysical indicators of blood − microrheological properties. Infusion of various solutions is used as replacement therapy for critical and terminal conditions.

Hemorheological disorders contribute to the development of hypoxia, the severity and duration of which determines the likelihood of septic complications, multiple organ failure and mortality [14].

Under the influence of unfavorable factors (disease, trauma, hypo, hyperthermia), various changes can occur with erythrocytes − the structure changes, normal functioning is disrupted.

Irreversible morphological changes in the erythrocyte often end in hemolysis − the destruction of the erythrocyte wall with the release of the cell contents into the environment. This happens when cells enter a hypotonic solution. In the body, some of the cells undergo physiological hemolysis. Hemolysis of erythrocytes also occurs in some diseases − hemolytic disease of newborns [15]; acute and chronic poisoning with nitrogen oxides, nitrobenzene, sodium nitrite [16] and other diseases. In critical conditions, massive hemolysis of erythrocytes in the blood vessels occurs. In this case, under conditions of hypoxia, acidosis, and reperfusion, Fe2 + ions are released [17]. In connection with the inhibition of enzymes, the metabolic process (ATP synthesis) is disrupted, the membrane permeability changes, and the ability to transport substances, including oxygen, decreases. Exposure to high temperatures is also reflected in the morphology of red blood cells. For example, with hyperthermia simulated in rats, there was a change in the diameter of erythrocytes [18], the elasticity of the cell walls decreased and tissue gas exchange worsened, and there was a significant increase in the hematocrit index [19].

At present, the issue of primary factors that initiate pathogenetically caused dysfunction of erythrocytes in burn injury in its acute period is not resolved, which is important for the timely appointment of pathogenetically determined complex of intensive care from the first minutes of hospital stay.

The aim of the article is to reduce the frequency of complications of severe burn injury in patients with impaired microcirculation of erythrocytes in the capillary bed by applying an algorithm aimed at improving their architecture and functional condition.

Materials and methods. This study is based on the analysis of the results of a comprehensive clinical-instrumental and laboratory dynamic study of hemodynamic parameters, biochemical markers of erythrocyte functional status and evaluation of the effectiveness of the proposed method of prevention and treatment in a cohort prospective randomized open clinical study in 96 patients with burn trauma. from the 1st day to 1 month from the moment of admission to the clinic, who were treated in Kharkiv City Clinical Hospital of Ambulance in the period 2018 − 2020.

The conditions for selecting patients for the study were age up to 60 years, the presence of burn injury, the possibility of productive contact with the patient at the time of admission (14-15 points for GCG), obtaining informed consent, compensation at the time of injury of any comorbidities, no history blood diseases, cancer, severe heredity, alcoholism, mental disorders, allergic reactions, blood transfusions, the use of immunocorrectors, glucocorticoids.

All patients were divided into 3 groups: group I, 32 patients, whose treatment was carried out according to the generally accepted protocol of the medical institution; group II − 32 patients who in addition to the main complex of intensive care was prescribed a solution of ceruloplasmin 1 time per day intravenously 6 mg / kg body weight at a rate of 30 drops per minute for 10 days; group III − 32 patients who in addition to the main complex of intensive care was prescribed a solution of D-fructose-1,6-diphosphate sodium salt hydrate intravenously at a rate of 10 ml per minute 150 mg / kg 2 times a day for 10 days.

All patients were in a state of burn shock, as determined by an integrated scale (Spronk P.E. et all., 2004). According to the rectal-skin temperature gradient, which normally averages 5.7 ± 0.4°C, patients had a second degree of burn shock with corresponding disorders of microcirculation. The average figures of the temperature gradient at the time of admission in all patients were 11.72 ± 1.1º.

Since changes in peripheral blood, such as hemoconcentration and increased viscosity, contribute to microcirculation during burns, and anemia is masked by hemoconcentration, it is important to determine the percentage of erythrocyte hemolysis, which is one of the prognostic criteria for burn injury.

Clinical blood test was performed on a GEM apparatus.

The level of haptoglobin in the blood was determined by immunoturbodimetry.

To determine the functional state of erythrocytes and their ability to deform, we used the method of scanning electron microscopy.

The method of scanning electron microscopy allows us to assess the surface architecture of cells, in our case − the resistance of erythrocyte membranes to mechanical impact. Control and test

samples were fixed with 2.5% glutaraldehyde solution at 4°C for 1 hour. Carried out dehydration of cells by centrifugation in a series of aqueous solutions of ethanol in ascending concentrations of 30, 50, 70, 90% and then − acetone. The prepared cell suspension was applied to aluminum substrates and dried in a thermostat at 37 ° C. To ensure the electrical conductivity of objects, they were sprayed with a thin film of gold. The preparations were examined on a scanning electron microscope JSM − 6380LU (Japan) at an accelerated voltage of 20-25 kV.

Patients in each group underwent smears and performed a general blood test, studied the morphometry of blood smears.

For a detailed analysis of changes in the surface architecture of erythrocytes, a number of indices were calculated:

TI − transformation index − quantitative assessment of the ratio of pathological and normal forms of erythrocytes:

TI = (RD% + ID%) / D%;

IOR − index of reversible transformation

IOR = OD% / D%;

IOI - index of irreversible transformation

IOI = ND% / D% (D − discocytes, ND − irreversible discocytes, OD − reversible discocytes).

The definition of these indices is based on the fact that normally most erythrocytes are represented by discocytamia. forms (Bessis M., Mohandas N., 1975).

The day of admission, the 3rd and 10th days of treatment were selected as control points. The criteria for the effectiveness of the prescribed therapy was to determine the number of days of treatment in the intensive care unit and the number and quality of complications that occurred in the studied patients.

To be able to use the Student's t test, the Fischer-Snedekor test was calculated − the ratio of the larger variance to the smaller one. All mathematical operations and graphical constructions were performed using the software packages "Microsoft Office XP": "Microsoft XP Home" and "Microsoft Excel XP".

Results of the research. When analyzing the aggregate and functional state of erythrocytes, we took into account the fact that the oxygenation of cells and tissues of the body largely depends not only on the ability of hemoglobin to bind and release oxygen, but also on the rheological properties of blood, which are largely determined by erythrocytes to deformation and aggregation, as their functions are carried out through the free surface of the membranes. It was important to statistically compare the studied indicators at the beginning of treatment, at the time of admission to the clinic (table 1), on the 3rd day of intensive care, as this term in terms of positive consequences in most cases coincides with the end of clinical manifestations of burn shock (table 2), and on the 10th day of treatment, when the additional prescribed substances have already taken effect, and you can determine the effectiveness of their use (table 3).

Table 1. Indicators of haptoglobin and surface architecture of erythrocytes in groups I, II and III in patients with burn trauma at the time of admission to the clinic

Indicators	Group I n = 32	Group II n = 32	Group II n = 32
Hemoglobin, g / l	151,2±9,2	154,1±9,4	152,6±7,4
Haptoglobin, g / l	0,3±0,01	0,3±0,02	0,3±0,01
Discocytes, %	64,6±6,1	64,9±4,2	64,8±9,4
Reverse discocytes, %	14,6±2,6	16,1±0,9	15,6±1,74
Irreversible discocytes, %	22,8±2,4	19,7±1,4	20,1±1,6
TI, %	0,57±0,02	0,55±0,04	0,56±0,02
IOR, %	0,24±0,01	0,24±0,01	0,24±0,02
IOI, %	0,34±0,02	0,32±0,01	0,31±0,02

An important point in determining the effect of additional prescribed substances in intensive care in patients with burn injury was the analysis of erythrocyte hemolysis. The statistical analysis of hemoglobin and haptoglobin levels in the blood of patients in groups I, II and III did not reveal significant differences, which confirmed the correct randomization of patients into groups at the screening stage in the study. Similar data were used to determine the indices that characterize the surface architecture of erythrocytes.

Table 2. Indicators of haptoglobin and superficial architecture of erythrocytes in groups I, II and III in patients with burn injury on the 3rd day of treatment

Indicators	Group I n = 32	Group II n = 32	Group II n = 32
Hemoglobin, g / l	117,4±6,8	128,1±2,6	122,6±7,4
Haptoglobin, g / l	0,1±0,01	0,6±0,04*[1,2]	0,3±0,02*[2,3]
Discocytes, %	62,6±4,2	71,9±2,9*[1,2]	64,7±3,1*[2,3]
Reverse discocytes, %	13,9±2,1	18,2±2,7	14,6±1,74
Irreversible discocytes, %	24,1±2,2	10,7±2,1*[1,2]	21,1±1,9*[2,3]
TI, %	0,61±0,01	0,41±0,02	0,55±0,02
IOR, %	0,22±0,02	0,25±0,01	0,22±0,02
IOI, %	0,38±0,02	0,14±0,01*[1,2]	0,32±0,02*[2,3]

Note: * − $p < 0.05$

On the 3rd day of treatment under conditions of strict infusion-transfusion therapy, in patients of group II, who were additionally prescribed a solution of ceruloplasmin, the level of hemoglobin in the blood was 128.1 ± 2.6 g / l, which was slightly higher indicators among other groups of patients. The level of haptoglobin in the blood turned out to be important data. Thus, in patients of group I, who used the classical algorithm of intensive care of burn injury, a sharp decrease in its numbers was determined, 0.1 ± 0.01 g / l, which against the background of hypohemoglobinemia, 117.4 ± 6.8 g / l, indicated in favor of advanced hemolysis.

Table 3. Indicators of haptoglobin and superficial architecture of erythrocytes in groups I, II and III in patients with burn injury on the 10th day of treatment

Indicators	Group I n = 32	Group II n = 32	Group II n = 32
Hemoglobin, g / l	123,6±7,1	134,1±2,1	126,2±2,2
Haptoglobin, g / l	0,2±0,04	1,2±0,04*[1,2]	0,3±0,08*[2,3]
Discocytes, %	64,2±4,1	78,4±2,9*[1,2]	69,8±3,7*[2,3]
Reverse discocytes, %	16,4±2,6	16,1±0,9	16,6±2,24
Irreversible discocytes, %	19,6±4,2	7,2±1,2*[1,2]	14,1±1,9*[2,3]
TI, %	0,56±0,04	0,29±0,01*[1,2]	0,44±0,01*[2,3]
IOR, %	0,26±0,02	0,21±0,04	0,24±0,01
IOI, %	0,31±0,02	0,11±0,02*[1,2]	0,21±0,04*[2,3]

Note: * − $p < 0.05$

In turn, in patients of group II, the maximum level of haptoglobin in the blood was determined on the 3rd day of observation, 0.6 ± 0.04 g / l, which was probably ($p < 0.05$) higher than its figures in the groups I and III. Identical dynamics was determined in the study of erythrocyte transformation indices. Thus, in patients of group II the total number of discocytes in the blood was 71.9 ± 2.9%, which was probably ($p < 0.05$) higher than in groups I and III, the number of irreversible discocytes in group II was probable ($p < 0.05$) less than in groups I and III (10.7 ± 2.1%), the index of irreversible transformation of erythrocytes also repeated this trend. At the same time, in patients of group III all these indicators differed significantly from the data in group I, but there were no significant differences between them due to the large variation of indicators in the variation range of patients.

On the 10th day of treatment, the trend towards the dynamics of changes in the studied indicators did not change. Thus, in patients of group I was determined the lowest level of hemoglobin in the blood, 123.6 ± 7.1 g / l, the lowest level of haptoglobin in the blood − 0.2 ± 0.04 g / l, which indicated in favor of hemolysis, which persisted even after 10 days of intensive care. These changes are also reflected in the indices of erythrocyte architectonics.

In group II, the level of haptoglobin was maximum, 1.2 ± 0.04 g / l, which was probably ($p < 0.05$) higher than in groups I and II, was the maximum percentage of total discocytes, 78.4 ± 2.9%, which was also likely ($p < 0.05$) higher than in groups I and III, the minimum percentage of irreversible discocytes, 7.2 ± 1.2%, which was also likely ($p < 0.05$) lower than in groups I and III. The index of irreversible transformation of erythrocytes in patients of group II was also minimal, 0.14 ± 0.01%, which was probably ($p < 0.05$) less than this figure in groups I and III.

Given the fundamentally different mechanism of action of substances additionally assigned to the complex of intensive care of burn injury − ceruloplasmin solution and solution of D-fructose-1,6-

diphosphate sodium salt of hydrate − it can be noted that the leading mechanism of erythrocyte dysfunction in patients with burn injury shock at the time of admission to the clinic is a violation of the mechanism of lipid peroxidation. The resulting oxidative stress contributes to the developed hemolysis of erythrocytes, which negatively affects the course of burn disease and its long-term consequences. Violation of the energy mechanisms of erythrocyte function is also significant. Given the significant changes in the studied parameters in patients of groups I and III, it can be argued about the important impact of erythrocyte membrane disorders with subsequent disruption of phosphate metabolism on the course of burn disease. Therefore, in the future it makes sense to investigate the combination of a solution of ceruloplasmin and a solution of D-fructose-1,6-diphosphate sodium salt hydrate in one algorithm of intensive care in this category of patients.

Conclusions.

The leading mechanism of complications in patients with burn injuries is oxidative stress.

Additional administration of ceruloplasmin solution probably reduces the severity of intravascular hemolysis and promotes faster recovery of erythrocytes.

Determination of erythrocyte transformation indices is an important point in determining the prognosis of the disease in patients with burn trauma with clinical signs of shock.

Conflict of interest. The authors do not declare a conflict of interest.

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FEATURES OF THE FUNCTIONAL STATE OF MUSCLE TISSUE IN ELDERLY PATIENTS WITH URGENT SURGICAL PATHOLOGY

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7440

ARTICLE INFO

Received: 10 December 2020
Accepted: 14 February 2021
Published: 28 February 2021

KEYWORDS

sarcopenia,
metabolic disorders,
levocarnitine,
intensive therapy.

ABSTRACT

Sarcopenia is an important factor in the occurrence of complications in elderly patients with urgent surgical pathology. Decreased muscle strength and function is an important criterion for impaired early activation of such patients, which increases the number of complications and length of stay in the clinic. Identification of functional disorders of muscle tissue, as well as other metabolic disorders, such as type 2 diabetes, disorders of lipid metabolism, is important for the appointment of an adequate complex of intensive care. Prescribing levocarnitine and D-fructose-1,6-diphosphate sodium salt of hydrate is an important part of the treatment program in such patients.

Citation: Rasenko Andrii. (2021) Features of the Functional State of Muscle Tissue in Elderly Patients with Urgent Surgical Pathology. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7440

Introduction. According to the European Working Group on Sarcopenia in Older People (EWGSOP), "Sarcopenia is a syndrome characterized by progressive and generalized loss of muscle mass and muscle strength with an increased risk of adverse events such as impaired mobility, impaired quality of life, or death." [1]. According to the US Center for Disease Control and Prevention (CDC), sarcopenia is considered one of the top five risk factors for morbidity and mortality in people over 65; associated with an increased risk of all-cause mortality and decreased self-care ability [2].

Sarcopenia is classified as primary or age-related when aging is the main cause of its development and other causes of this condition are excluded [3]. Sarcopenia, which develops against the background of severe eating disorders or restrictions on mobility, as well as against the background of other diseases, is secondary [4]. Sarcopenia is a polyetiologic disease, and therefore, in some patients it is difficult and impossible to isolate primary or secondary sarcopenia.

Multiple factors are associated with decreased muscle mass and / or strength in older adults [5, 6]. The underlying causes or mechanisms associated with sarcopenia include inadequate nutrition, lack of exercise, bed rest, age-related hormonal changes, loss of motor neurons, atherosclerosis, obesity, insulin resistance, and exposure to inflammatory cytokines.

With age, the distribution of fat mass in the body changes, there is an increase in abdominal fat and a decrease in subcutaneous fat mass [7, 8]. Simultaneously, there is a decrease in the quality of muscles, namely, a decrease in the size and number of muscle fibers (loss of type II fibers prevails), a decrease in muscle protein synthesis and a decrease in mitochondrial function [9, 10]. In patients with an excessive amount of fat mass, a change in lipid metabolism in muscles was noted. Increased infiltration of muscle tissue with lipids and adipose tissue both inside and around muscle cells. This is likely due to a systemic increase in free fatty acids [11]. According to the literature, the results of computed tomography demonstrate, when scanning at the level of the middle third of the thigh, an increase in the amount of fat mass in and around the muscles [12]. Thus, aging includes an increase and redistribution of fat mass, and changes in muscle mass: "more fat, less muscle."

The aim of the study was to determine the severity of sarcopenia in elderly patients with urgent surgical pathology of the abdominal cavity.

Materials and methods.

The study was a clinical prospective open cohort randomized and was conducted on the basis of the Department of Anesthesiology and Intensive Care for patients of the surgical profile of the municipal non-profit enterprise "City Clinical Hospital of Ambulance and Emergency Care. prof. OI Meshchaninov" Kharkiv City Council and on the basis of the Department of Intensive Care of the State Institution" Institute of General Emergency Surgery named after V.T. Zaitseva" of the National Academy of Medical Sciences of Ukraine (2019–2020). To achieve this goal, we examined 90 elderly patients (73.3 ± 7.9 years) with surgical pathology of the abdominal cavity, who underwent emergency surgery under general anesthesia based on sodium thiopental with artificial lung ventilation, the average duration of which was 109,2 ± 24,6 min. The inclusion criteria were: age at least 60 years; absence of somatic diseases in the stage of decompensation, class II-III according to the ASA classification. Depending on the protocol of postoperative therapy, patients were divided into 3 groups, and they were domesticated by age, sex, anthropometric data, volume and duration of surgery and concomitant comorbid background (table 1).

Table 1. Clinical characteristics of the examined patients, (M ± σ)

Indicators	Groups		
	I	II	III
Number of patients	30	30	30
Men	9	10	8
Women	21	20	22
Age, years	72,4±6,1	72,1±5,6	72,2±5,9
Height, sm	161,2±10,4	164,4±12,1	162,6±11,9
Body weight, kg	76,8±7,9	78,4±6,7	78,1±6,9
Duration of operation, min.	109,4±31,1	110,1±29,6	109,8±32,2

Group I (n = 30) - patients who underwent standard intensive perioperative therapy, group II (n = 30): standard intensive therapy with the addition of levocarnitine from the first day of stay in the intensive care unit 15 mg / kg body weight per day intravenously slowly; group III (n = 30): standard intensive care with the addition of levocarnitine from the first day of stay in the intensive care unit 15 mg / kg body weight per day intravenously slowly for 5 days and a solution of D-fructose-1,6-diphosphate sodium salt of hydrate 150 mg / kg 2 times daily intravenously at a rate of 10 ml per minute for 5 days in the clinic.

By type a concomitant somatic pathology, patients were distributed as follows: hypertension 1-2 tbsp. I group of 12 patients, II group of 14 patients, III group of 12 patients; coronary heart disease Group I 17 patients, Group II 15 patients, Group III 14 patients; heart failure I-IIA class I group 22 patients, II group 20 patients, III group 18 patients; type II diabetes mellitus group I 28 patients, group II 27 patients, group III 27 patients. All patients with confirmed type II diabetes mellitus at the time of admission received metformin 1827.2 ± 236.1 mg per day as antidiabetic therapy.

During the interview, the patient clarified the presence of complaints of impaired mobility, difficulty walking, getting up from a chair. Anamnestic data on the presence of falls and fractures in the anamnesis were evaluated. At the time of admission, data on glycated hemoglobin levels and other laboratory parameters (glucose, creatinine, total protein and albumin, serum lipid parameters, protein in single and / or daily urine) were copied from outpatient charts, statements, medical histories.

The diagnosis of sarcopenia was based on the recommendations proposed by the European Working Group on Sarcopeniain Older People (EWGSOP, 2009) [1].

The diagnosis was based on the determination of muscle mass, strength and function. When diagnosing sarcopenia, the EWGSOP recommends the following criteria: Decreased muscle mass combined with decreased muscle strength or muscle function.

There were 3 stages of sarcopenia, according to EWGSOP recommendations: presarcopenia, sarcopenia, severe sarcopenia [1]. In patients with a decrease in muscle mass index alone, the stage of presarcopenia was established; with a decrease in muscle mass and muscle strength, the stage of sarcopenia was established.

The study of muscle mass was performed immediately after surgery in the operating room using the method of bioimpedancemetry on the analyzer "MEDASS" ABC-02. After obtaining the results of the measurement of skeletal muscle mass in kg, the calculation of the musculoskeletal mass index (SMM (kg) / height (m2) = ISMM, kg / m2) was performed. The ISMM corresponding to the decrease in muscle mass was taken to be less than 6.75 kg / m2.

Evaluation of muscle strength was performed by the method of wrist dynamometry using a mechanical wrist dynamometer DK-25, the evaluation of this indicator was performed taking into account the body mass index.

To be able to use the Student's t test, the Fischer-Snedekor test was calculated - the ratio of the larger variance to the smaller one. All mathematical operations and graphical constructions were performed using the software packages "Microsoft Office XP": "Microsoft XP Home" and "Microsoft Excel XP".

Results of the research.

It was important to determine the peculiarities of metabolism and muscle condition in patients at the time of their occurrence of urgent surgical pathology. Since, according to many authoritative sources [13, 14], more than 80% of elderly patients treated in surgical clinics have a reduced sarcopenic index, regardless of body mass index, it was important to compare the length of stay of patients in groups I, II and III in the intensive care unit and in the clinic in general, taking into account the additional appointment in patients of groups II and III of substances that in one way or another affect the functional state of the muscles.

On the first day of stay in the clinic we will identify the following features of the metabolism of the studied patients (table 2).

Table 2. Clinical characteristics of the studied patients

Indicators	Groups		
	I (n=30)	II (n=30)	III (n=30)
Presarcopenia, %	53% (16)	47% (14)	43% (13)
Sarcopenia, %	47% (14)	53% (16)	57% (17)
BMI, (kg / m2)	26,2±0,4	25,9±0,2	26,4±0,6
HbA1c (%)	8,4±0,2	7,9±0,4	8,1±0,4
Dynamometry (right hand, best result from 2 attempts), kg	16,2±1,2	15,9±1,6	16,4±1,7
Reduced muscle strength according to KDM data, (%)	67,2±3,1	65,8±5,2	66,1±4,9
Intake of statins, %	93%	90%	96%
Creatinine, μmol / L	82,4±6,2	81,8±4,6	82,2±5,1
GFR, ml / min / 1,73m2	60,2±8,2	62,6±7,1	61,9±6,4
Total cholesterol, mmol / l	5,08±0,4	4,48±0,6	5,11±0,2
Total protein, g / l	72,4±2,7	71,9±4,4	70,2±2,6
The number of treatment days in ICU	5,4±1,1	4,1±0,4	$3,2\pm0,2^{*I,III}{}^{*II,III}$

***** - $p<0,05$ - probable difference between groups

At the initial analysis to determine the metabolic status of elderly patients treated in the surgical department for emergency surgery was 53%, 47% and 43% in patients of groups I, II and III, respectively, or sarcopenia, 47%, 53% and 57% in patients of groups I, II and III, respectively. Also important was the presence of elevated glycated hemoglobin (HbA1c), which was $8.4 \pm 0.2\%$, $7.9 \pm 0.4\%$ and $8.1 \pm 0.4\%$ in patients of groups I, II and III, respectively, which indicated the presence of type II diabetes mellitus, which characterizes the corresponding changes in the body by carbohydrate metabolism. Despite the almost normal body mass index in most patients, BMI 26.2 ± 0.4 kg / m2, 25.9 ± 0.2 kg / m2 and 26.4 ± 0.6 kg / m2 in groups I, II and III, respectively, it was important to determine the dynamics and muscle strength, which confirmed the presence of presarcopenia / sarcopenia in all patients. Thus, in group I the indicators of dynamometry and muscle strength were 16.2 ± 1.2 kg and $67.2 \pm 3.1\%$, in group II - 15.9 ± 1.6 kg and 65.8 ± 5.2 %, in group III - 16.4 ± 1.7 kg and $66.1 \pm 4.9\%$, respectively.

It was important to obtain data on the use of statins in the studied patients. Thus, more than 90% of elderly patients admitted to a surgical hospital with urgent pathology had disorders of lipid metabolism. The block status of patients was satisfactory, which indicated the acute origin of surgical pathology.

Given the fact that the fundamental difference between the groups, taking into account the pathogenetic mechanisms of sarcopenia, was the appointment of a solution of levocarnitine in group II and a solution of levocarnitine in parallel with a solution of D-fructose-1,6-diphosphate sodium salt of hydrate in group III, probable ($p<0.05$) differences in the number of days of treatment of patients in the intensive care unit, 5.4 ± 1.1 days in group I, 4.1 ± 0.4 days in group II, 3.2 ± 0.2 days in patients of group III indicated the importance of the functional state of the muscles during the postoperative period in elderly patients with urgent surgical pathology.

Conclusions.

Sarcopenia in elderly patients admitted to a surgical hospital is an important factor influencing the duration of treatment in the intensive care unit and, consequently, the occurrence of complications.

The appointment of levocarnitine is pathogenetically justified in this group of patients as a protector of the functional state of muscle tissue.

The appointment of D-fructose-1,6-diphosphate sodium salt of hydrate is an important component of the algorithm of intensive care in elderly patients with surgical pathology, which has an energy-protective effect and promotes their early activation.

Conflict of interest. The authors do not declare a conflict of interest.

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THE PROBLEM OF POSTOPERATIVE COGNITIVE DYSFUNCTION IN PATIENTS WITH OBESITY IN EMERGENCY SURGERY

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7441

ARTICLE INFO

Received: 18 December 2020
Accepted: 15 February 2021
Published: 28 February 2021

KEYWORDS

endothelial dysfunction, cognitive disorders, obesity, L-arginine hydrochloride.

ABSTRACT

The occurrence of postoperative cognitive dysfunction is a negative consequence of vascular endothelial dysfunction in patients with grade I-II obesity with appropriate metabolic shifts and comorbid background, which increases the duration of treatment and worsens the prognosis in patients with acute surgical pathology. It is important to add endothelioprotectors to the intensive care unit. L-arginine hydrochloride has been shown to be pathogenetically justified as a prophylaxis for an increase in the level of antigens to von Willebrand factor in the blood of obese patients with acute surgical pathology. Administration of this substance before and during surgery is likely to improve mental performance in the postoperative period in patients with elevated body mass index, who underwent emergency cholecystectomy.

Citation: Maisuradze Alla. (2021) The Problem of Postoperative Cognitive Dysfunction in Patients with Obesity in Emergency Surgery. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7441

Introduction. One of the indicators of the quality of surgical treatment is the course of the early postoperative period. It is considered smooth if successful [1, 2]. The causes of complications in the early postoperative period are many. Most often they are due to various objective reasons. One of such reasons is the inevitable impact on the body of surgical trauma [3, 4].

Any surgery is a serious stress for the patient's body. During them, the patient is exposed to various aggressive factors that significantly affect the functioning of many body systems. As a result, in some patients, surgical treatment induces the occurrence of pathological conditions that require special rehabilitation [5]. That is why there is a need to study the impact of the level of surgical trauma on the postoperative period.

In turn, it is known that obesity in the body there are numerous changes characterized by reduced functionality of organs and systems, reduced, and in some cases, distortion of metabolic processes, reduced reactivity and resistance (or resistance) to stress [6, 7]. In this regard, anesthesia and intensive care in patients with high body mass index differs from that in other weight groups due to altered metabolism of drugs, altered sensitivity to them of organs and tissues, excellent distribution of drugs in altered water sectors and associated with increased surgical and anesthetic risk, complications [8].

It should be noted that at present there is a lot of information about the traditional list of postoperative complications, which are mostly somatic disorders. However, it is important to take into account the fact that surgical treatment can induce various inconspicuous abnormalities that are difficult to diagnose. These deviations do not cause severe disorders of life, but can significantly reduce the quality of life in the postoperative period in a significant proportion of operated patients. One such pathological condition is postoperative cognitive dysfunction syndrome (POCD). POKD - syndrome of cognitive impairment due to general anesthesia and surgery, which has a multifactorial etiology, develops in the early and persists in the late postoperative period, clinically manifests itself in the form of memory impairment, difficulty concentrating and impaired other cognitive functions language, etc.), which is confirmed by neuropsychological testing [9, 10].

Recently, around the world began to appear quite a lot of work on this issue. However, specific data on the etiology of POCD, especially in patients with elevated body mass index in the emergency clinic is not enough.

The questions of the dependence of the severity of POCD on the body mass index and the concomitant somatic condition of such patients, on the impact of surgical trauma and severity at the time of admission to the hospital also remain unexplored [11, 12].

The aim of the study was to increase the effectiveness of intensive care in patients with high body mass index in the emergency clinic by improving the methods of influencing perioperative risk factors.

Materials and methods. The study selected 84 patients who were treated in the surgical department for acute surgical pathology (cholecystectomy), had grade I-II obesity lasting more than 10 years. All patients had concomitant somatic diseases, which in their clinical development adversely affected the functional state of the vascular endothelium. Given that the operation itself and general anesthesia led to the pathogenetic mechanism of surgical stress, it was important to maintain the functional state of the endothelium at the most satisfactory level, which directly affected the state of POCD in the studied patients.

All patients were divided into 3 groups: group I, 28 patients who received the standard protocol of perioperative intensive care, group II, 28 patients who in addition to the standard protocol of perioperative intensive care was prescribed a solution of meglumine sodium succinate intravenously at a rate of 90 drops per minute immediately before the operation and on the 30th minute 200 ml of 1.5% solution (N-methylglucamine (meglumine)) - 8.725 g, succinic acid - 5.28 g). The appointment was due to the fact that one of the most important factors in postoperative cognitive dysfunction is the possible biochemical changes in homeostasis that may occur during general anesthesia and be associated with the activation of lipid peroxidation; group III, group II, 28 patients who in addition to the standard protocol of perioperative intensive care was prescribed a solution of L-arginine hydrochloride intravenously at a rate of 90 drops per minute immediately before surgery and at the 30th minute in 100 ml of a solution of 42 mg / ml.

To confirm the adequate randomization of patients in terms of endothelial function in all patients before surgery and 12 hours after it was determined the level of von Willebrand factor antigen, % (reference values 50-150%).

The integrative function was assessed by mnestico-intellectual indicator using a short scale of mental status research MMSE (maximum score on the MMSE scale 30 points); in order to eliminate the effect of memorization in the tests, used different options for their implementation. A decrease in the MMSE test by 10% or more was regarded as a manifestation of POCD.

Short-term memory was evaluated by the indicator of auditory short-term memory by the method of Luria - memorization of 5 words.

Control points were selected 12 hours after awakening after anesthesia, 3rd and 5th days of treatment.

To be able to use the Student's t test, the Fischer-Snedekor test was calculated - the ratio of the larger variance to the smaller one. All mathematical operations and graphical constructions were performed using the software packages "Microsoft Office XP": "Microsoft XP Home" and "Microsoft Excel XP".

Results of the research. When assessing the functional status of the endothelium in terms of the percentage of antigens to von Willebrand factor as a leading marker for the determination of endothelial dysfunction (VWF: Ag), no significant difference was found between groups of patients. Thus, before the operation, in patients of group I its average level was 182.1 ± 26.2%, in patients of group II - 196.4 ± 22.9%, in patients of group III - 189.6 ± 28.2%, $p > 0.05$. The presence of endothelial dysfunction in all studied patients, which was caused by somatic pathology, was determined.

When conducting a statistical analysis of indicators that characterize the functional state of the endothelium (table 1), we identified probable differences between indicators in the groups.

Table 1. The level of VWF: Ag, %, in the blood of the studied patients

Moment of control	Groups		
	Group I	Group II	Group III
Before surgery	182,1±26,2	196,4±22,9	189,6±28,2
12 hours after regaining consciousness after anesthesia	204,2±16,6	198,4±19,2	182,1±7,9 *I,III

* - $p<0,05$ - probable difference between indicators

Thus, during intensive care according to the standard protocol 12 hours after surgery in patients of group I was found to increase the level of VWF: Ag, 204.2 ± 30.6%, relative to baseline in the vast majority of patients in this group, which indicated about the deterioration of endothelial function caused by surgical stress. In patients of group II, who were additionally prescribed meglumine solution, the level of the studied indicator remained at the initial level, 198.4 ± 19.2%, which indicated the presence of endothelioprotective properties in the complex of intensive care of this group of patients. In patients of group III, who were additionally prescribed a solution of L-arginine hydrochloride, the level of antigens to von Willebrand factor was probably ($p<0.05$) less than in patients of group I, 182.1 ± 7.9%, and less in the predominant the number of patients of group II, which indicated the severity of endothelioprotective properties of the intensive care unit in patients of group III.

Important from the point of view of the pathogenetic necessity of prescribing endothelioprotectors on the 3rd and 5th days of treatment (table 2), given the presence at the time of admission in all patients of compromised endothelial function on the background of obesity and concomitant somatic pathology.

Table 2. Dynamics of cognitive parameters in the studied patients

Groups	Terms of inspection, days		
	1 (12 hours after surgery)	3	5
MMSE, points			
Group I	24,2±0,6	25,7±0,4	26,1±0,2
Group II	26,1±0,4	26,1±0,6	26,9±0,4
Group III	28,8±0,2*^{1,3*2,3}	29,2±0,4*^{1,3*2,3}	29,6±0,1*^{1,3*2,3}
Test 5 words, points			
Group I	7,2±0,7	7,9±0,4	8,2±0,4
Group II	7,4 ±0,9	8,3±0,2	8,6±0,1
Group III	9,4±0,2*^{1,3*2,3}	9,6±0,4*^{1,3*2,3}	9,7±0,2*^{1,3*2,3}

* - $p<0,05$ - probable difference between indicators

Statistical analysis of changes in cognitive abilities on the MMSE scale in the postoperative period in patients of groups I, II and III found that surgery in itself - surgical stress, as well as general anesthesia during surgery adversely affect almost all cognitive parameters. Thus, in patients of group I and group II the dynamics of deterioration of cognitive abilities coincided with an increase in the level of VWF: Ag in the blood. Thus, 12 hours after surgery, the total score of the functional state of higher nervous activity on the MMSE scale in patients of group I was 24.2 ± 0.6 points, group II - 26.1 ± 0.4 points, which corresponded to the unsatisfactory state of cognitive abilities for this contingent of patients. In group III, this indicator was 28.8 ± 0.2 points, which was probably ($p<0.05$) more than in groups I and II and indicated in favor of more pronounced endothelioprotective properties of the intensive care protocol in this group. The dynamics of cognitive changes was identical according to the Luria test.

On the 3rd day and the 5th day of treatment, there was a corresponding trend in the restoration and realization of cognitive abilities in the studied patients.

Conclusions.

In patients with urgent surgical pathology and surgical intervention in this regard (cholecystectomy), who for more than 10 years have grade I-II obesity with appropriate metabolic changes and comorbid background, it is important to implement endothelioprotection as a prophylactic method of cognitive dysfunction in the period after.

Oxidative stress does not have a pathogenetically destructive effect on the vascular endothelium in such patients, so the appointment of meglumine in intensive care is not important.

In contrast, the administration of L-arginine hydrochloride is important, provides endothelioprotection and counteracts the occurrence of postoperative cognitive dysfunction.

Conflict of interest. The authors do not declare a conflict of interest.

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THE ROLE OF VASCULAR HOMEOSTASIS IN WOMEN WITH INFERTILITY TREATED WITH ASSISTED REPRODUCTIVE TECHNOLOGIES AND WITH CONCOMITANT INTRAHEPATIC CHOLESTASIS

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7442

ARTICLE INFO

Received: 14 December 2020
Accepted: 16 February 2021
Published: 28 February 2021

KEYWORDS

pregnancy, intrahepatic cholestasis, endothelium, infertility, ART.

ABSTRACT

Intrahepatic cholestasis of pregnancy (idiopathic jaundice of pregnancy, recurrent familial jaundice of pregnancy) is a benign familial disease manifesting itself in the gestational period in itching and (or) jaundice. As a rule, the disease is observed in the 3rd trimester of pregnancy, that is in the 28th-30th week, and may disappear by itself a few days after labor and recur during future pregnancies.

The aim of this research is to study the role and factors of vascular homeostasis regulation in women with infertility treated with assisted reproductive technologies (ART) and with concomitant intrahepatic cholestasis.

Intrahepatic cholestasis is characterized by the damage of endothelial cells of hepatic sinusoids, changes in the intrahepatic hemodynamics, increased production of cytokines and free radicals. The processes of angiogenesis in the liver are also closely connected with the functional capacity of endothelium. The L-arginine level in blood was measured using the photometric method based. The homocysteine level was measured by the enzymatic cycling method. To measure the level of placental growth factor (PGF) in blood plasma samples, we used the immunochemical method.

The research has found especially severe complications in the course of pregnancy after ART in those women with intrahepatic cholestasis whose placentas developed under the conditions of endothelial dysfunction from the very beginning of pregnancy.

So, these factors may be early prognostic markers of severe obstetrical and perinatal disorders in women with induced pregnancy and hepatobiliary disorders.

Citation: Oleksandra Hryhorivna Boichuk, Svitlana Mykolaivna Heryak, Stefan Volodymyrovych Khmil, Mariya Stefanivna Khmil. (2021) The Role of Vascular Homeostasis in Women with Infertility Treated with Assisted Reproductive Technologies and with Concomitant Intrahepatic Cholestasis. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7442

Introduction. Cholestatic hepatosis of pregnancy (or intrahepatic cholestasis of pregnancy - IHCP) is a cholestatic disease that manifests itself in the 2nd or the 3rd trimester of pregnancy in pruritus, increased levels of aminotransferases and bile acids (BA), changes in the activity of hepatic

enzymes and is characterized by spontaneous disappearance of signs and symptoms within two or three weeks after labor [1, 2]. In some studies, IHCP is also called idiopathic intrahepatic cholestasis or hepatosis of pregnancy. Indeed, it is a transitory hepatic dysfunction that disappears within 1 to 3 weeks after labor. IHCP was first mentioned by F. Ahlfeld in 1883 in the Reports and Records of the Clinic of Obstetrics and Gynecology in Hessen [3].

One should also bear in mind that, due to the exhaustion of its reserve potential in the course of pregnancy, the liver becomes more vulnerable (Sidorova I.S., 2003; Friedman S.A., 1998, Girling J., 1997). One should pay special attention to its functioning in case of development of gestational toxicosis; in the pathogenesis of its severe forms, changes in the hepatobiliary system are the key factor (Christina Song, 1998).

Intrahepatic cholestasis of pregnancy is observed in 1-2 out of 1000 pregnancies in the United States [4]. As a rule, it manifests itself in the 3rd trimester, with the onset around the 30th week of pregnancy (on average) and the disappearance of symptoms after labor. The differential diagnosis includes viral hepatitis, autoimmune hepatitis, primary biliary hepatic cirrhosis and cholelithiasis.

Additional risk factors include the pregnant woman's age, multifetal pregnancy, diseases in anamnesis or in relatives, liver diseases before the pregnancy, cholestasis, intake of oral contraceptives [5, 6].

There are several theories of the disease pathogenesis, including the hormonal, the genetic and other theories. According to the hormonal theory, increased secretion of progesterone and other placental hormones in the pregnant woman's body impedes the release of gonadotropic hormones from the hypophysis and leads to increased cholesterol synthesis in the liver and decreased capacity of the membranes of hepatocytes and bile canaliculi to release bile acids. What lies at the basis of pathogenesis is a disorder of cholepoiesis and choleresis as 17β-estradiol gets to bile canaliculi and inhibits the bile salt export pump, hampering the transport of bile acids into bigger ducts [7,8].

Endothelial dysfunction is known to be a universal pathogenic mechanism of the majority of diseases as endothelium does not only regulate vascular tone but is also involved in the processes of atherogenesis, thrombosis and protection of the integrity of vessel walls [Golovchenko Y.I., Treshchinskaya M.A., 2008]. Besides, endothelium produces a big number of biologically active substances that influence vascular tone and angiogenesis, regulate hemostasis, adhesion and aggregation of platelets, immune and anti-inflammatory responses [Gomazkov O.A., 2000; Aird W.C., 205].

Liver diseases are characterized by the damage of endothelial cells of hepatic sinusoids, changes in the intrahepatic hemodynamics, increased production of cytokines and free radicals [Yermolov S.Y., 2000]. The processes of angiogenesis in the liver are also closely connected with the functional capacity of endothelium. Nitric oxide (NO) is synthesized by hepatocytes and cells of the reticulo-endothelial system of the liver [Ratnikova L.I., Melnikov I.V., 2002]. Affected by chronic processes, the liver suffers from the inhibition of the NO biosynthesis processes, which leads to an imbalance between vasoconstrictors and vasodilators [Hon W.M., 2002].

Aim of research – identifying the role of endothelial dysfunction and factors of vascular homeostasis regulation in the development of obstetrical and perinatal complications in women with infertility treated with ART and with concomitant intrahepatic cholestasis.

Materials and methods of research. We have analyzed and divided into groups 90 women with infertility treated with ART. The basic group consisted of 50 women diagnosed with intrahepatic cholestasis in the 2nd and the 3rd trimester of pregnancy, while the other 40 women did not present the above mentioned disorder (comparison group). In addition and contrast to these 90 women with infertility treated with assisted reproductive technologies, we have also considered 20 women who got pregnant without ART (reference group).

The L-arginine level in blood was measured using the photometric method based on the reaction of α-naphthol with a hypobromite reagent. The homocysteine level was measured by the enzymatic cycling method with the use of the DiaSys kit (Germany) and the Respons 920 analyzer (Germany), following the producer's instructions. To measure the level of placental growth factor (PGF) in blood plasma samples, we used the immunochemical method with electrochemiluminescent immunoassay (ECLIA).

Research results and their discussion. Endothelial dysfunction also plays an important role in reproductive disorders, in particular infertility and recurrent miscarriage [9, 10]. Some authors even consider it to be the basis of pathogenesis of such conditions.

Among the numerous factors of endothelial origin, nitric oxide (NO) is a generally recognized marker of endothelial dysfunction. Nitric oxide is produced from L-arginine under the influence of the nitric oxide synthase enzyme (NOS). It is to this L-arginine / nitric oxide system that the contemporary obstetrics attributes the major vasoregulatory role in the gestational period [11, 12].

Special importance for the development of the vascular network of placenta and for its normal functioning is attributed to the vascular factors that stimulate the proliferation of endothelial cells and increase their viability, which include the vascular endothelial growth factor (VEGF), the placental growth factor (PGF) and the basic fibroblast growth factor (bFGF) [13, 14].

An important factor of reproductive and obstetrical disorders is hyperhomocysteinemia, which leads to the damage and activation of endothelial cells and significantly increases the risk of thrombosis. Homocysteine induces apoptosis of trophoblastic cells and significantly decreases the production of chorionic gonadotropin, which may cause obstetric complications related to implantation disorders [15].

Taking into account the contemporary view of endothelial dysfunction as a universal trigger mechanism of reproductive disorders, the role of vascular changes in the placentation process disorder as well as the genetic susceptibility of women with infertility diagnosed with intrahepatic cholestasis to endothelial dysfunction (unfavorable variants of the eNOS gene polymorphism) that we found in our research, we considered it necessary to study in such women the levels of L-arginine as the NO donor, of homocysteine as an endothelium-damaging factor and of PGF as a factor of angiogenesis [16, 17, 18].

We have researched the indicators that characterize endothelial function and may damage endothelium in 50 women with infertility treated with ART and with concomitant intrahepatic cholestasis (basic group), in 40 women without such hepatobiliary disorders (comparison group) and in 20 women who got pregnant without ART (reference group). The research rysults (Table 1) have shown in the women of the basic group a decreased level of L-arginine, that is the only source of nitric oxide – the main vasorelaxant factor (44.9±1.1 vs. 49.6±1.3, $p<0.05$), which may be indicative of endothelial dysfunction. We have also noticed a trend towards hyperhomocysteinemia, which implies a high risk of endothelium damage, negative influence on the coagulation system, microcirculation disorders and negative influence on the reproductive function. [19, 20, 21].

Table 1. Indicators of vascular hemostasis regulation in women with infertility and functional hepatic disorders

Indicator	Group of women		
	Basic group	Comparison group	Reference group
L-arginine, mmol/l	44.9±1.1	49.6±1.3	53.6±1.4
Homocysteine, micromole/l	6.5±0.36	5.7±0.32	6.2±0.32

Note: * - the difference is significant with regard to the indicator in women from the comparison group ($p<0.05$).

To assess the condition of vascular regulation in pregnant women with functional hepatic disorders after treatment with ART, depending on the development of obstetric and perinatal complications, we have studied the respective indicators in 50 women with intrahepatic cholestasis (basic group), 40 pregnant women treated with ART but presenting no hepatobiliary disorder (comparison group) and 20 healthy women who got pregnant naturally (reference group) in the 14-16th week of pregnancy. As shown in Table 2, the women of the basic group present significant changes in the analyzed indicators. For instance, one can see a significant decrease in comparison with the reference group of the L-arginine level (44.2±1.1 vs. 52.6±1.4 mmol/l ($p<0.05$)) and an increase of the homocysteine level. One should also note a significantly decreased level of PGF in blood (91.4±8.6 vs. 132.4±11.5 pg/ml in women from the reference group, $p<0.05$), which is indicative of disorders of the angiogenesis processes, which, in their turn, have a negative impact on the development and functioning of placenta and lead to complications of pregnancy and disorders of the condition of the fetus, which were often observed in women with hepatobiliary changes.

Table 2. Indicators of vascular homeostasis regulation in pregnant women after ART

Indicator	Group of pregnant women		
	Basic group	Comparison group	Reference group
L-arginine, mmol/l	(44.2±1.1)*	47.3±1.3	52.6±1.4
Homocysteine, micromole/l	(6.9±0.30)*	6.2±0.36	5.8±0.33
PGF in blood, pg/ml	(91.4±8.6)*	118.8±9.5	132.4±11.5

Note: * - the difference is significant with regard to the indicator in women from the reference group ($p<0.05$).

To identify the role of the disorders of vascular homeostasis regulation in the development of complications of pregnancy in case of hepatic disorders, we have singled out 2 subgroups in the basic group: Subgroup 1 – 19 women with significant obstetrical and perinatal disorders (miscarriages and non-developing pregnancies, severe preeclampsia, decompensated fetal distress), Subgroup 2 – 31 women without such disorders. The research results show (Table 4) especially severe complications in the course of pregnancy after ART in those women with intrahepatic cholestasis whose placentas developed from the very

beginning of pregnancy under the conditions of endothelial dysfunction (decrease of the L-arginine level to 39.8±2.0 mmol/ l vs. 45.8±1.6 in women without significant disorders of the gestational process, $p<0.05$), negative influence of homocysteine (increase to 7.4±0.44 vs. 6.4±0.36 micromole/l, $p<0.05$), disorders of angiogenesis processes (decrease of the PGF level in blood to 70.5±11.9 vs. 103.7±9.8 pg/ml, $p<0.05$).

Table 3. Indicators of vascular homeostasis regulation in pregnant women after ART

Indicator	Subgroup of women	
	1	2
L-arginine, mmol/l	(39.8±2.0)*	45.8±1.6
Homocysteine, micromole/l	(7.4±0.44)*	6.4±0.36
PGF in blood, pg/ml	(70.5±11.9)*	103.7±9.8

Note: * - the difference is significant with regard to the indicator in women of Subgroup 2 ($p<0.05$).

So, these factors may be early prognostic markers of such obstetrical and perinatal disorders in case of induced pregnancy.

Conclusions. Especially severe complications in the course of pregnancy after ART were observed in those women with intrahepatic cholestasis whose placentas developed from the very beginning of pregnancy under the conditions of endothelial dysfunction (decreased L-arginine level), negative influence of homocysteine and disorders of angiogenesis processes (decreased PGF level in blood). Thus, these factors may be early prognostic markers of severe obstetrical and perinatal disorders in case of induced pregnancy.

Conflict of Interest. The authors confirm that there are no conflicts of interest.

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ПРОФІЛАКТИКА РОТАЦІЇ ТОРИЧНИХ ІНТРАОКУЛЯРНИХ ЛІНЗ ПІСЛЯ ФАКОЕМУЛЬСИФІКАЦІЇ КАТАРАКТИ НА ОЧАХ З РОГІВКОВИМ АСТИГМАТИЗМОМ З ВИКОРИСТАННЯМ СТАНДАРТНОГО КАПСУЛЬНОГО КІЛЬЦЯ

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7443

ARTICLE INFO

Received: 21 December 2020
Accepted: 16 February 2021
Published: 28 February 2021

KEYWORDS

cataract, corneal astigmatism, cataract phacoemulsification, toric IOL, astigmatic correction.

ABSTRACT

We have developed a method of preventing TIOL rotation by using a standard capsule ring. We examined 46 patients (59 eyes) who underwent phacoemulsification and implanted TIOL. Rotation of TIOL 6 months after surgery in the control group with 22 eyes (70.9%), in the main group - with 12 eyes (42.85%). In the main group in all cases, the deviation of the TIOL axis did not exceed 6 degrees. The proposed method of prevention of rotation of TIOL allows to increase the efficiency of phacoemulsification of cataracts.

Citation: Nataliia Zavgorodnya, Valeriia Novikova, Tamila Tsybulska. (2021) Prevention of Toric Intraocular Lens Rotation After Cataract Phacoemulsification in the Eyes with Corneal Astigmatism Using a Standard Capsule Ring. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7443

Вступ. Факоемульсифікація катаракти сьогодні є найрозповсюдженішим оперативним втручанням на органах зору. Малоінвазивність, високотехнологічність та швидкість відновлення зорових функцій роблять дане оперативне втручання безпечним і таким, що не потребує госпіталізації [1]. Найбільшу дискусію серед факохірургів та науковців викликає питання корекції астигматизму, так як відомо, що близько 30% населення світу мають рогівковий астигматизм від 0,75Д і вище, який призводить до зниження гостроти зору після факоемульсифікації катаракти [2].

Найбільш розповсюдженим методом корекції рогівкового астигматизму є імплантація торичних інтраокулярних лінз (ТІОЛ), що забезпечує короткий реабілітаційний період та високі функціональні результати [3, 4].

Головним критерієм отримання високої гостроти зору при імплантації ТІОЛ є точне взаєморозташування астигматичного компоненту штучного кришталика та сильного меридіану рогівки. Розходження даних параметрів на 1° знижує величину циліндричного компоненту лінзи на 3,3%, а на 10° - на 35% [5]. Окрім точної орієнтації ТІОЛ по вісі астигматизму під час операції, важливим фактором високої гостроти зору на таких очах є стабільність імплантованої торичної лінзи в післяопераційному періоді. Ротація ТІОЛ у віддалені строки після операції

супроводжується значним зниженням гостроти зору та погіршенням його якості і потребує повторного оперативного втручання – репозиції ІОЛ.

Сьогодні триває пошук та розробка шляхів стабілізації торичних інтраокулярних лінз. Одним з таких є розробка допоміжних методів та засобів за типом чи із застосуванням внутрішньокапсульного кільця [6,7,8].

Більше 20 років застосовуються внутрішньокапсульні стабілізуючі кільця (за міжнародною абревіатурою «capsule tension rings» (CTR)) при факоемульсифікації катаракти. Вони отримали широке розповсюдження як пристрої, що дозволяють хірургам розширити межі успішних ендокапсулярних втручань в першу чергу при ускладнених ситуаціях, таких як сублюксація кришталика з порушенням його зв'язкового апарату [8].

Нами розроблено спосіб профілактики ротації ТІОЛ з використанням стандартного капсульного кільця, який відрізняється тим, що кільце імплантується в капсульний мішок після імплантації ТІОЛ і виставлення її відповідно сильного меридіану та розташовується поверх гаптичних елементів штучного кришталика (Патент України на корисну модель №145036, опубл. 10.11.2020, Бюл.№21) [9].

Мета роботи оцінити ефективність використання запропонованого способу профілактики ротації торичної інтраокулярної лінзи після факоемульсифікації катаракти на очах з рогівковим астигматизмом.

Матеріали і методи дослідження В роботі представлені результати дослідження, проведеного в клініці сучасної офтальмології «ВІЗУС», що є клінічною базою кафедри офтальмології ЗДМУ. Проведене комплексне клініко-офтальмологічне обстеження 46 пацієнтів (59 очей), прооперованих з приводу катаракти та супутнього рогівкового астигматизму методом факоемульсифікації катаракти з імплантацією торичної ІОЛ. Сила супутнього рогівкового астигматизму становила від 0,5Д до 4,25Д за даними кератометрії (в середньому 1,96 ± 0,1 Д). Вік пацієнтів коливався від 26 до 81 (середній вік – 54,3 ± 1,74 роки). За статтю досліджувані хворі розподілялися майже нарівно: чоловіків було 27 (45,8%), жінок – 32 (54,2%). На 30 очах (51%) мала місце незріла катаракта, на 22-х (37%) – початкова, на 1 оці (2%) – зріла, а на 6-ти очах (10%) була виконана рефракційна заміна кришталика в зв'язку з аметропією та пресбіопією.

На всіх досліджуваних очах були імплантовані торичні інтраокулярні лінзи, найчастіше за вибором пацієнта: 27 – монофокальних (AT TORBI 709M/MP (Carl Zeiss Meditec, Німеччина) та AcrySof IQ Toric (Alcon, США)), 14 – біфокусних (AT LISA toric 909M (Carl Zeiss Meditec, Німеччина) та AcrySof IQ ReSTOR (Alcon, США)) та 18 трифокальних ТІОЛ (AT LISA tri toric 909M (Carl Zeiss Meditec, Німеччина). Пацієнти були прооперовані двома хірургами, індивідуальний індукований астигматизм яких не перевищував 0,25Д. Тунельний розріз виконувався в меридіані 160-180 градусів. На всіх очах операція та післяопераційний період перебігали без ускладнень. Термін спостереження становив 6 місяців після операції.

Всі прооперовані хворі були розподілені на 2 групи. В першу групу (контрольну) були віднесені 26 пацієнтів (31 око), де факоемульсифікація та імплантація торичної ІОЛ виконувалася за стандартною технікою без застосування методик, що перешкоджають ротації штучного кришталика в післяопераційному періоді. Другу групу (основну) склали 20 хворих (28 очей), що були прооперовані за запропонованою нами методикою [9].

На всіх очах до та після операції виконували ряд стандартних офтальмологічних обстежень (візометрія, авторефрактометрія на автоматичному рефрактометрі URK 700 (Unicos, Південна Корея), біомікроскопія, пряма офтальмоскопія, тонометрія, периметрія), ультразвукове А- та В-сканування на апараті PACSCAN 300A SERIES (Sonomed, USA), ендотеліальна мікроскопія з підрахунком кількості ендотеліальних клітин рогівки за допомогою приладу SP-3000P (TOPCON, Японія), оптична біометрія та розрахунок ІОЛ на апараті IOLMaster700 (Carl Zeiss, Німеччина). Гостроту зору визначали за системою Снеллена, результати представлені в десятинній системі. Додатково розрахунок торичної ІОЛ дублювався на апараті Verion® (Alcon, США) та через використання он-лайн калькулятора «Z CALC Online IOL Calculator» (Carl Zeiss, Німеччина).

Статистичну обробку виконували за допомогою пакета програм Statistica 13.0, номер ліцензії JPZ8041382130ARCN10-J. Проводився розрахунок середньої арифметичної варіаційного ряду (M) та її стандартної помилки (m). Для порівняння кількісних величин в парних рядах використовували t-критерій Стьюдента з попередньою перевіркою гіпотези про нормальність розподілу змінних (Shapiro–Wilk W test) в варіаційному ряду. При відсутності нормального розподілу величин в досліджуваних вибірках застосовувався непараметричний критерій Манна-Уїтні. Відмінності вважали статистично вірогідними при значенні $p < 0,05$.

Результати. Головним критерієм ефективності факоемульсифікації катаракти у хворих з супутнім рогівковим астигматизмом є висока гострота зору без циліндричної корекції та її збереження в післяопераційному періоді, що досягається стабільністю положення ТІОЛ в капсульному мішку. На рис.1 представлені середні показники гостроти зору після оперативного втручання в першій (контрольній) та другій (основній) групах в динаміці.

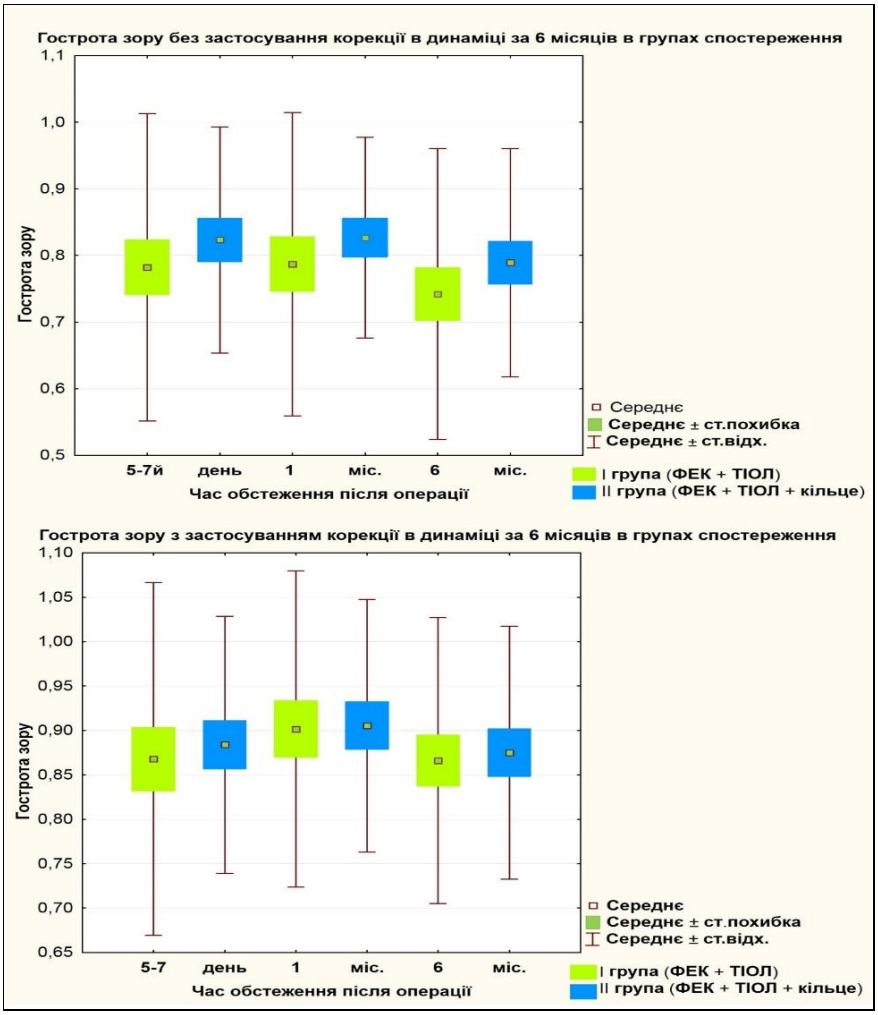

Рис.1. Показники гостроти зору після ФЕК з імплантацією ТІОЛ в групах спостереження через 5-7 днів, 1 місяць та 6 міс. після операції

Примітка: різниця з відповідними показниками між групами у всіх випадках не достовірна, p>0,05.

Як видно з представлених діаграм, середні показники гостроти зору між групами різняться в межах одного рядка, але важливим є те, що розбіг результатів, які ми оцінюємо за вусами шкали розмаху – менш виражений саме в основній групі, де застосовувалась імплантація внутрішньокапсульного кільця. Також помітно, що різниця за середніми показниками гостроти зору без застосування корекції збільшувалась з часом після операції. Так через 6 міс. після операції середні значення гостроти зору без застосування корекції у першій групі - 0,74 ± 0,03, у другій – 0,78 ± 0,03. В першій групі на 13 очах (41,93%) через 6 місяців після операції зберігалася максимальна гострота зору (0,9 та вище), в 14ти випадках (45,16%) корекція не була потрібна для покращення рефракційного результату, на 4 очах (12,9%) була необхідна сферична корекція, на 12 очах (38,7 %) – циліндрична, на 1оці (3,2 %) - сферо-циліндрична.

В другій групі, де застосовувалась запропонована методика імплантації внутрішньокапсульного кільця поверх ТІОЛ, через 6 місяців гострота зору 0,9-1,0 зберігалась на 14 очах (50,0 %), в 14ти випадках (50,0%) корекція не була потрібна для покращення рефракційного результату, на 4 очах(14,2 %) покращувала гостроту зору сферична корекція, на 5 (17,8 %) – циліндрична, в 5 випадках (17,8 %) знадобилась сферо-циліндрична корекція.

Як правило, ротацію ТІОЛ оцінюють за динамікою гостроти зору та відповідності осі лінзи до такої під час імплантації. В таблиці 1 наведені результати досягнення максимальної

гостроти зору в основній та контрольній групах через 1 та 6 місяців. Більш ранні результати вважали непоказовими для оцінки стабільності ТІОЛ в капсульному мішку.

Таблиця 1. Динаміка гостроти зору на очах з катарактою та рогівковим астигматизмом після ФЕК з імплантацією ТІОЛ в групах спостереження.

Строки спостереження	Гострота зору					
	0,9 – 1,0 (кількість очей, %)		0,7-0,9 (кількість очей, %)		<0,7 (кількість очей, %)	
	Основна група	Контрольна група	Основна група	Контрольна група	Основна група	Контрольна група
1 місяць	13 (46,4%)	14 (45,1%)	11 (39,2%)	9 (29,0%)	4 (14,2%)	8 (25,8%)
6 місяців	14 (50%)	13 (41,9%)	8(28,5%)	8 (25,8%)	6 (21,42%)	10 (32,2%)

З таблиці видно, що відсоток очей в контрольній групі, які мали гостроту зору від 0,7 та вище через 1 міс після операції склав 74,1% (23 ока), а через 6 місяців після операції - 67,7% (21 око). В той час як в основній групі через 1 місяць після ФЕК + ТІОЛ на 24 очах (85,6%). була досягнута висока гострота зору (0,7 та вище). Різниця між показниками гостроти зору за групами спостереження не була статистично значимою (p>0,05). Зменшення кількості очей з високими показниками гостроти зору через 6 місяців в основній групі до 22 (78,5%) було зумовлено розвитком вторинної катаракти на 2 очах.

В подальшому проведений аналіз стабільності положення ТІОЛ в капсульному мішку протягом часу. Для цього порівнювали вісь імплантації лінзи та її положення станом через 6 місяців післяопераційно. Положення внутрішньоочної лінзи оцінювали за допомогою щілинної лампи та розміщення світлового пучка паралельно насічок на ТІОЛ на прооперованому оці. Через 6 місяців після операції ротація інтраокулярної лінзи виявлена в контрольній групі на 22 очах (70,9%), в основній групі - на 12 очах (42,85%). Причому в контрольній групі в більшості випадків (на 13 очах, 59 % з числа ротованих) було зафіксоване відхилення вісі інтраокулярної лінзи в межах 6 градусів і більше, в той час, як в основній групі у всіх випадках (12 очей, 100 % з ротованих) відхилення вісі імплантації лінзи не перевищувало 6 градусів.

На рисунку 2 представлені результати відхилення вісі ТІОЛ через 6 місяців після операції в основній та контрольній групах.

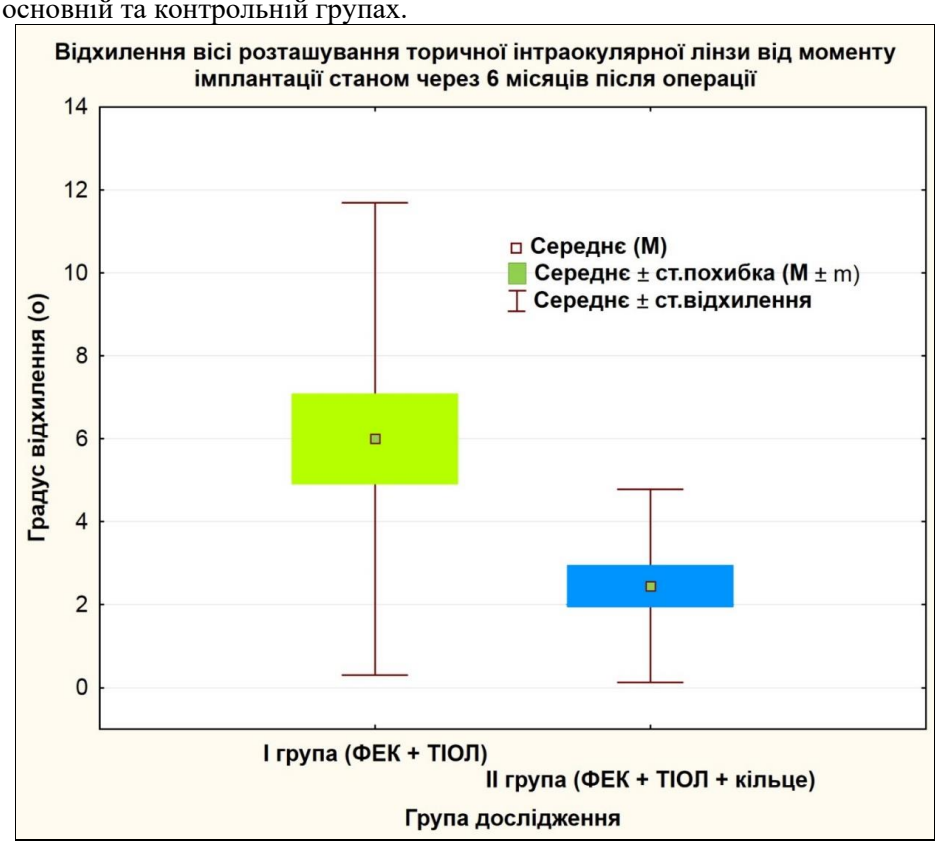

Рис.2. Середні значення та розбіг показників відхилення вісі положення торичної інтраокулярної лінзи через 6 міс. після ФЕК в досліджуваних групах (p<0,05).

Аналізуючи отримані дані можна сказати, що положення ТІОЛ у групі, де додатково імплантувалось внутрішньокапсульне кільце за запропонованою методикою, було більш стабільне, лінза зберігала своє висхідне положення краще, а саме середній показник відхилення був на рівні 2,14±0,4 градуси (max – 6º, min – 0º), що не мало суттєвого значення для зорових функцій.

В той же час в контрольній групі групі середній показник відхилення становив – 5,41±1,01 градуси (max – 30º, min – 0º), що впливало на гостроту зору та суб'єктивні відчуття – дискомфорт, двоїння і неможливість бачити на близькій відстані при імплантованій мультифокальній ТІОЛ. Різниця між середнім показником відхилення вісі імплантації торичної лінзи в контрольній групі є статистично достовірною ($p<0,05$).

Слід зауважити, що в 2 випадках пацієнти з першої групи спостереження потребували повторного оперативного втручання з причини значної ротації ТІОЛ.

Клінічні приклади:

1. Пацієнтка Д., 1961 р.н., оперована з приводу встановленого діагнозу: «Незріла катаракта, складний міопічний астигматизм правого ока».

Висхідний астигматизм – 2,75 Д. Імплантована ТІОЛ – AT Torbi 709 M (Carl Zeiss Meditec, Німеччина) через 1 місяць після операції потребувала додаткової циліндричної корекції у 1,5Д. На плановому огляді виявлено, що лінза ротувалась на 30 градусів на фоні виражених фіброзних змін капсульного мішка. Гострота зору знизилась до 0,5 без корекції, з додатковою корекцією sph -0,5D та cyl +1,5D дорівнювала 1,0. Хвора скаржилася на нечіткість зору, двоїння, незадоволення результатом оперативного лікування. Пацієнтка була прооперована: інтраокулярна лінза була повернута в висхідне положення, згідно передопераційного розрахунку та стабілізована за допомогою імплантації в капсульний мішок поверх гаптичних елементів ТІОЛ стандартного розімкнутого кільця діаметром 13 мм із закругленими кінцями. При огляді на 1-у добу після операції гострота зору дорівнювала 1.0 (через діафрагму), внутрішньоочний тиск в нормі, ІОЛ розташована в капсульному мішку і займає правильне положення. Через 6 міс. після повторної операції гострота зору прооперованого ока = 1.0, внутрішньоочний тиск в нормі, положення ТІОЛ стабільне, ротації не виявлено.

2. Пацієнтка Н., 1967 р.н., оперована з приводу встановленого діагнозу: «Початкова катаракта лівого ока. Міопія середнього ступеню, складний міопічний астигматизм лівого ока».

Висхідний астигматизм – 2,25 Д. Імплантована ТІОЛ – AT LISA tri toric 909M (Carl Zeiss Meditec, Німеччина). Цей випадок цікавий тим, що пацієнтка потребувала двох додаткових втручань. При першому втручанні виконана репозиція ротованої на 20 градусів лінзи стандартним способом: ТІОЛ була повернута в висхідне положення згідно передопераційного розрахунку. На другий день гострота зору оперованого ока становила 0,95 через діафрагму, на 7й день Vis OS - 0,7 не корегує. Знову з'явились скарги на двоїння та нечіткість зору, неможливість читати на близькій відстані. При огляді виявлено, що ТІОЛ повернулась в положення до репозиції. Пацієнтка потребувала повторного оперативного втручання. Під час операції виявлено фіброзні зміни капсульного мішка, які і призводили до зміни положення гаптичного елементу, що викликало повторне зміщення лінзи. Друга репозиція виконана з використанням додаткового капсульного кільця за запропонованим нами способом для досягнення максимальної стабільності положення лінзи. Через 6 місяців після повторної операції гострота зору оперованого ока становила 100%, внутрішньоочний тиск в нормі, положення ТІОЛ стабільне.

Обговорення. Офтальмохірурги у всьому світі намагаються вирішити питання ротації та стабільності положення торичної інтраокулярної лінзи у капсульному мішку у її висхідній запланованій вісі. Так Г.А. Федоров та В.В. Егоров розробили пристрій для підвищення ротаційної стабільності торичних інтраокулярних лінз, який мав вигляд незамкнутого плоского капсульного кільця з двома шарнірами на кінцях і м'яким стопором в формі циліндра в центральній частині кільця. Дане кільце після імплантації обертають всередині капсульного мішка за годинниковою стрілкою до тих пір, поки положення стопора не співпаде з відміткою на рогівці, що позначає положення сильного меридіана астигматизму. Потім в капсульний мішок імплантують ТІОЛ і обертають її за годинниковою стрілкою та розташовують з упором основи її опорного елемента в силіконовий стопор, що в сукупності повинно відповідати вісі астигматизму [6]. Даний спосіб добре стабілізував лінзу та мав суттєві недоліки. По-перше не було налагоджено широке промислове виробництво такого кільця, що перешкоджало широкому впровадженню в практику, по-друге виникали певні складнощі при імплантації

вказаного капсульного кільця, особливо при недостатній ширині зіниці, щоб силіконовий стопор зайняв правильну вісь з урахуванням надалі імплантованої ТІОЛ.

Кузнєцов С.Л. и Галлєєв Т.Р. зі співавторами також розробили внутрішньокапсульне кільце, особливістю якого була наявність на внутрішній поверхні еластичних елементів у вигляді трьох зубців з зазорами, для фіксації гаптичного елементу імплантованої надалі ТІОЛ за типом «скрепки» [7, 8]. З недоліків можна продублювати вищевказані для попереднього пристрою.

Одержані дані та наведені клінічні приклади свідчать про те, що імплантація додаткового капсульного кільця за запропонованою нами методикою перешкоджає ротації торичної лінзи в капсульному мішку. На наш погляд це відбувається завдяки двом ефектам: 1) капсульне кільце стабілізує капсульний мішок та запобігає його деформації при розвитку фіброзних процесів та 2) додатковий тиск кільця на гаптичні елементи ТІОЛ також зменшує вірогідність ротації та вільного пересування лінзи у капсульному мішку.

Слід зауважити, що в роботах Vokrojová M, Havlíčková L, Brožková M та Hlinomazová Z. не виявлено достовірної різниці в ротаційній стабільності імплантованого кришталика з наявністю або відсутністю внутрішньокапсульного кільця [10]. Отримані нами дані про більшу стабільність торичної інтраокулярної лінзи при імплантації стандартного капсульного кільця обґрунтовуються саме етапністю імплантації лінзи та капсульного кільця. Запропонована нами методика відрізняється тим, що додатково фіксує гаптичні елементи саме імплантованим поверх них капсульним кільцем.

Висновки. Таким чином можна зробити наступні висновки:

1. Запропонований спосіб профілактики ротації торичної інтраокулярної лінзи в капсульному мішку з використанням стандартного капсульного кільця, що імплантується поверх гаптичних опорних елементів штучного кришталика, дозволяє підвищити ефективність хірургічного лікування катаракти на очах з рогівковим астигматизмом, забезпечує довготривалий стабільний результат зорових функцій, знижує частоту повторних оперативних втручань з приводу репозиції ротованої торичної інтраокулярної лінзи та може бути рекомендований для використання у практиці катарактальних хірургів.
2. Використання стандартного капсульного кільця за запропонованою методикою дозволяє запобігти ротації торичної інтраокулярної лінзи більше, ніж на 6 градусів в 100% випадків, що суттєво не впливає на гостроту зору та не потребує додаткових оперативних втручань.
3. Представлений спосіб профілактики ротації торичної інтраокулярної лінзи дозволяє досягти високої гостроти в 85,6% випадків.

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ВНУТРІШНЬОПЕЧІНКОВИЙ ХОЛЕСТАЗ ВАГІТНИХ ПІСЛЯ ЗАСТОСУВАННЯ ДОПОМІЖНИХ РЕПРОДУКТИВНИХ ТЕХНОЛОГІЙ: КЛІНІЧНІ ОСОБЛИВОСТІ

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7444

ARTICLE INFO

Received: 24 December 2020
Accepted: 17 February 2021
Published: 28 February 2021

KEYWORDS

intrahepatic cholestasis of pregnant women, assisted reproductive technologies, pregnancy, labor, obstetric and perinatal complications.

ABSTRACT

80 pregnant women were examined after assisted reproductive technology (ART) programs: 40 women with manifestations of intrahepatic cholestasis of pregnant women (IHP) - the main group and 40 women without manifestations of IHP (comparison group).
In the majority (62.5%) of patients after ART, the diagnosis of IHP established after 30 weeks of pregnancy. Some patients (27.5%) reported short-term episodes of IHP up to 24 weeks of gestation. In 17.5% of women, IHP had a severe course. Almost a third (27.5%) of women are over 35 years old. Women with IHP have a significantly higher frequency of allergies in the anamnesis (35.0%), liver pathology (20.0%) and diseases of the gastrointestinal tract (25.0%). In one third of women, IHP developed repeatedly, 42.5% of the main patients indicated a family history burdened with IHP. Almost a third of women (27.5% vs. 12.5%, $p<0.05$) had a history of polycystic ovary syndrome.
The current pregnancy characterized by a high frequency of complications. A quarter of patients (25.0%) had early preeclampsia. In the second half of pregnancy, the threat of preterm birth noted in most women during the manifestation of IHP (60.0%). The incidence of fetal distress in women with IHP was almost 2 times higher than in patients without this complication (47.5% vs. 25.0%, respectively, $p <0.05$). The frequency of preeclampsia is also higher (40.0%).
The vast majority of women in the main group were born by cesarean section (70.0%). Almost half of patients with IHP were premature (45.0%). A third of women (35.0%) had fetal distress in childbirth. In 27.5%, childbirth complicated by bleeding of more than 5% of body weight. The postpartum period was characterized by a 4-fold increase in the frequency of late bleeding (20.0% vs. 5.0%, $p <0.05$).
One case of antenatal mortality noted in pregnant women after ART with IHP. Almost half of the children were born with asphyxia of varying severity (48.7%), with 10.3% diagnosed with severe asphyxia. One third of children were born with a body weight below 2500 g (30.8%). In 74.4% of newborns from mothers of the main group, various disorders of the period of early neonatal adaptation were noted, among which the most prominent were: RDS (35.9%), jaundice (43.6%) and gastrointestinal syndrome (30.8%). The 2-fold increased incidence of hemorrhagic syndrome (17.9%) is noteworthy.

Citation: Boychuk O. G., Ebae N. E. N., Zhdanovich O. I., Kolomiichenko T. V., Savchenko A. S. (2021) Intrahepatic Cholestasis of Pregnant Women After the Use of Assisted Reproductive Technologies. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7444

Вступ. Внутрішньопечінковий холестаз вагітних (ВПХВ) – найбільш поширена патологія печінки характерна для вагітності, яку деякі дослідники навіть вважають однією з форм гестозу, проявляється свербінням і підвищенням концентрації жовчної кислоти в сироватці крові, як правило, розвивається в кінці II-III триместру і швидко проходить після пологів [1, 2, 3].

Вагітних після допоміжних репродуктивних технологій (ДРТ) відносять до групи ризику акушерських і перинатальних ускладнень, зокрема і ВПХВ, що обумовлено як негативним впливом самих технологій, старшим віком жінок, так і супутніми соматичними станами, серед яких певне місце посідає ендокринна та гепатобіліарна патологія [4, 5, 6].

Окрім неприємних для матері симптомів, при ВПХВ відмічають наступні акушерські і перинатальні ризики, точна частота яких не встановлена: передчасні пологи (4-12 %), зростання частоти застосування кесаревого ростину (до 36 %), підвищений ризик внутрішньоутробної загибелі плода, потрапляння меконію у навколоплодові води, респіраторний дистрес-синдром у новонародженого [7, 8, 9], які деякі дослідники вважають характерними для ВПХВ навіть при безсимптомному його перебігу [10]. Існує думка, що перенесений ВПХВ має несприятливі віддалені наслідки на стан здоров'я жінки та дитини [11, 12].

Мета дослідження. Встановити клінічні особливості перебігу вагітності, пологів, стану плода і новонародженого при внутрішньопечінковому холестазі вагітних після застосування допоміжних репродуктивних технологій.

Матеріали і методи дослідження. Комплексно обстежено 80 вагітних після програм ДРТ: 40 жінок з проявами ВПХВ (основна група) і 40 жінок без проявів ВПХВ (група порівняння). 50 жінок зі спонтанною вагітністю фізіологічного перебігу склали контрольну групу.

Критеріями включення були: наявність у вагітної достовірного діагнозу внутрішньопечінкового холестазу, підтвердженого клінічними (свербіж) і лабораторними даними (підвищення концентрації жовчних кислот. трансамінази, білірубіну); відсутність у вагітної інших захворювань гепатобіліарної системи, що супроводжуються синдромом внутрішньопечінкового холестазу.

Категоріальні змінні представлені як абсолютне число випадків у групі та частота у відсотках – n (%). Тестування відмінностей між незалежними вибірками здійснювали за допомогою точного критерію Фішера. При проведенні статистичного аналізу розраховували рівень значущості (p), критичним вважали рівень 0,05.

Результати досліджень. У більшості (62,5%) пацієнток основної групи діагноз ВПХВ встановлено після 30 тижнів вагітності, у інших (37,5%) – від 24 до 30 тижнів (табл. 1). Деякі пацієнтки (27,5%) відмічали короткочасні епізоди проявів ВПХВ до 24 тижнів вагітності. Провідним клінічним симптомом був шкірний свербіж: від незначного локального (долоні, ступні, передня черевна стінка, передпліччя, гомілки) у 42,5% пацієнток до нестерпного генералізованого, що посилюється вночі, супроводжується безсонням та психоемоційними розладами у 12,5% жінок. Свербіж супроводжувався розчісуваннями шкіри з поодинокими екскоріаціями 75,0% до множинних екскоріацій у 15,0%. У переважної більшості вагітних з ВПХВ клінічні прояви з боку ШКТ не відмічались, найчастіше спостерігали тошноту (35,0%), поодинокі випадки блювоти (5,0%), стеатозу (7,5%) та зниження апетиту (12,5%). У 7 (17,5%) жінок ВПХВ мав тяжкий перебіг (нестерпний свербіж з порушеннями загального стану, жовтяниця, значне підвищення рівня жовчних кислот, суттєві зміни інших лабораторних показників).

Проводилась диференціальна діагностика з обтураційною жовтяницею, жовчокам'яною хворобою, гепатитами, HELLP-синдромом, прееклампсією, гострою жировою дистрофією печінки, шкірними захворюваннями, алергічними реакціями, інфекційним мононуклеозом (вірус Епштейна-Барр) і цитомегаловірусом; гострими та хронічними гепатитами, спадковими захворюваннями печінки. УЗД органів черевної порожнини - без особливостей. Маркери вірусних гепатитів негативні.

Таблиця 1. Клінічні прояви ВПХВ у вагітних після ДРТ

Клінічний прояв ВПХВ	абс.ч.	%
Початок до 30 тижнів вагітності	15	37,5
Прояви ВПХВ до 24 тижнів вагітності	7	27,5
Шкірний свербіж: незначний локальний (передня черевна стінка, передпліччя, гомілки)	17	42,5
інтенсивний локальний без порушення сну	18	45,0
генералізований з порушенням сну, емоційними розладами	5	12,5
Стан шкірних покривів: відсутність екскоріацій	4	10,0
поодинокі екскоріації	30	75,0
множинні екскоріації	6	15,0
Жовтяниця: відсутня	7	17,5
субіктеричність	29	72,5
виражена іктеричність	4	10,0
Прояви з боку ШКТ: відсутні	27	67,5
тошнота	14	35,0
блювота	2	5,0
стеатоз	3	7,5
зниження апетиту	5	12,5
Тяжкий перебіг	7	17,5

У основній групі майже третина (27,5%) жінок старших за 35 років (проти 12,5 та 8,0% у групі порівняння та контрольній групі, $p<0,05$), що відповідає даним інших дослідників, які відносять вік старше 35 років до факторів ризику ВПХВ.

Жінки після лікування безпліддя методами ДРТ мають обтяжений соматичний анамнез (табл. 2). При цьому у жінок з ВПХВ суттєво вища частота як відносно пацієнток групи порівняння, так і відносно групи порівняння алергії в анамнезі (35,0% проти 17,5 та 18,0% відповідно, $p<0,05$), патології печінки (20,0% проти 7,5 та 4,0%, $p<0,05$) та захворювань ШКТ (25,0% проти 10,0 та 6,0%, $p<0,05$).

Таблиця 2. Екстрагенітальна патологія у обстежених жінок

Показник	Група обстежених					
	Основна, n= 40		Порівняння, n= 40		Контрольна, n = 50	
	абс.ч.	%	абс.ч.	%	абс.ч.	%
Алергія в анамнезі	14	35,0*#	7	17,5	9	18,0
Серцево-судинна патологія	6	15,0	7	17,5*	3	6,0
Патологія сечовидільної системи	10	25,0*	6	15,0	5	10,0
Патологія ЩЗ	7	17,5*	6	15,0*	2	4,0
Патологія печінки	8	20,0*#	3	7,5	2	4,0
Захворювання ШКТ	10	25,0*#	4	10,0	3	6,0

Примітки: * - різниця достовірна щодо показника жінок контрольної групи ($p<0,05$)
- різниця достовірна щодо показника жінок групи порівняння ($p<0,05$).

Відносно контролю обтяженим був і акушерсько-гінекологічний анамнез пацієнток після ДРТ (табл. 3).

Таблиця 3. Акушерсько-гінекологічний анамнез обстежених жінок

Показник	Група обстежених					
	Основна, n= 40		Порівняння, n= 40		Контрольна, n = 50	
	абс.ч.	%	абс.ч.	%	абс.ч.	%
Перша вагітність	18	45,0	16	40,0	29	58,0
Перші пологи	27	67,5	28	70,0	34	68,0
Штучні аборти	12	30,0*	11	27,5*	4	8,0
Викидні, завмерлі вагітності	13	32,5*	14	35,0*	3	6,0
Мертвонародження	2	5,0	1	2,5	-	-
ВПХ при попередніх вагітності	12	30,0*#	2	5,0	1	2,0
Обтяжений сімейний анамнез (ВПХ у матері і/або сестри)	17	42,5*#	2	5,0	1	2,0
СПКЯ	11	27,5*#	5	12,5*	1	2,0

Примітки: * - різниця достовірна щодо показника жінок контрольної групи ($p<0,05$)
- різниця достовірна щодо показника жінок групи порівняння ($p<0,05$).

За паритетом вагітностей та пологів групи суттєво не розрізнялись, при цьому частота штучних абортів та викиднів і завмерлих вагітностей суттєво не розрізнялась у основній групі та групі порівняння, проте була значно вища відносно жінок зі спонтанною вагітністю. Звертає на себе увагу той факт, що у третини жінок ВПХВ розвинувся повторно (30,0% жінок основної групи відмітили ВПХВ при попередніх вагітностях, тоді як у групі порівняння та в контролі були лише одиночні випадки). Більше 40% (42,5%) пацієнток основної групи вказували на обтяжений по ВПХВ сімейний анамнез (ВПХВ у матері та/або рідної сестри), що свідчить про спадкову обумовленість захворювання. Майже третина вагітних з ВПХВ (27,5% проти 12,5 та 2,0% в групі порівняння та в контролі, $p<0,05$) мали в анамнезі синдром полікистозних яєчників (СПКЯ), що також може бути фактором ризику даного ускладнення вагітності.

Теперішня вагітність у жінок після лікування безпліддя методами ДРТ характеризувалась вищою частотою ускладнень відносно вагітних контрольної групи (табл.4).

Так, у І половині вагітності у пацієнток основної групи у 2 рази частіше по відношенню до інших груп спостерігався ранній гестоз (тошнота та блювота вагітних), частота загрози переривання вагітності відмічалась у половини жінок як основної групи, так і групи порівняння, що характерно для вагітності після ДРТ ($p>0,05$).

У ІІ половині вагітності у більшості жінок при маніфестації ВПХВ відмічено загрозу передчасних пологів (60,0% проти 32,5 та 4,0% у групі порівняння та в контролі відповідно, $p<0,05$). Плацентарна дисфункція діагностувалась у половини жінок обох груп після ДРТ. Частота дистресу плода у жінок з ВПХВ була майже у 2 рази вищою ніж у пацієнток без цього ускладнення (47,5% проти 25,0% відповідно, $p<0,05$). Вища також і частота прееклампсії (40,0% проти 22,5%, $p<0,05$).

Загальна оцінка біофізичного профілю плода (БПП), найбільш об'єктивної інтегральної оцінки його стану, у пацієнток з ВПХБ склала 7,23±0,48 проти 9,36±0,41 та 9,93±0,16 балу у жінок групи порівняння та контрольної групи відповідно ($p<0,05$ в обох випадках).

Гемодинамічні порушення матково-плацентарно-плодового кровообігу I-II ступеня у були виявлені у 22 (55,0%) вагітних основної групи проти 11 (25,0%) пацієнток групи порівняння ($p<0,05$) та у 12 (12,0%) жінок контрольної групи ($p <0,05$). Критичні порушення кровотоку були виявлені у 6 (15,0%) жінок основної групи та 2 (5,0%) жінок групи порівняння, що стало показанням до достроkового розродження у 5 (12,5%) та 1 (2,5%) випадку відповідно ($p<0,05$).

Для жінок, вагітних після застосування програм ДРТ, характерна підвищена частота ускладнених пологів (табл. 5).

Таблиця 4. Ускладнення перебігу вагітності у обстежених жінок

Показник	Група обстежених					
	Основна, n= 40		Порівняння, n= 40		Контрольна, n = 50	
	абс.ч.	%	абс.ч.	%	абс.ч.	%
Ранній гестоз	10	25,0*	5	12,5	5	10,0
Загроза переривання вагітності	19	47,5*	21	52,5*	5	10,0
Загроза передчасних пологів	24	60,0*#	13	32,5*	2	4,0
Плацентарна недостатність	21	52,5*	22	55,0*	4	8,0
Анемія	14	35,0*	11	27,5	9	18,0
Дистрес плода	19	47,5*#	10	25,0*	3	6,0
Прееклампсія	16	40,0*#	9	22,5*	2	4,0
- легкого ступеня	11	27,5*	6	15,0*	2	4,0
- тяжкого ступеня	5	12,5	2	5,0	-	-
ЗРП	14	35,0*	10	25,0*	2	4,0

Примітки: * - різниця достовірна щодо показника жінок контрольної групи (p<0,05)
- різниця достовірна щодо показника жінок групи порівняння (p<0,05).

Таблиця 5. Частота ускладнень в пологах у обстежених жінок

Показник	Група обстежених					
	Основна, n= 40		Порівняння, n= 40		Контрольна, n = 50	
	абс.ч.	%	абс.ч.	%	абс.ч.	%
Кесарів розтин	28	70,0*	21	52,5*	7	14,0
Передчасні пологи	18	45,0*#	8	20,0*	3	6,0
Слабкість пологової діяльності	4	10,0	6	15,0	6	12,0
Швидкі (стрімкі) пологи	6	15,0*	2	5,0	2	4,0
Дистрес плода в пологах	14	35,0*#	7	17,5	4	8,0
Кровотеча > 0,5 % маси тіла	11	27,5*#	5	12,5	2	4,0

Примітки: * - різниця достовірна щодо показника жінок контрольної групи (p<0,05)
- різниця достовірна щодо показника жінок групи порівняння (p<0,05).

Переважна більшість жінок основної групи розроджена шляхом кесаревого розтину (70,0% проти 52,5% пацієнток групи порівняння, p>0,05). Передчасними були пологи майже у половини пацієнток з ВПХВ (45,0% проти 20,0% у групі порівняння, p<0,05), що співпадає з думкою інших дослідників про збільшення ризику передчасних пологів при ВПХВ. У третини жінок (35,0% проти 17,5% у групі порівняння) відмічено дистрес плода в пологах. У 27,5% в основній групі проти 12,5% у групі порівняння пологи ускладнились кровотечею більше 5% маси тіла, що може бути зумовлено дефіцитом вітаміну К, характерним для ВПХВ.

Післяпологовий період (табл. 6) у пацієнток основної групи характеризувався збільшеною у 4 рази відносно групи порівняння частотою пізніх кровотеч (20,0% проти 5,0% відповідно, p<0,05).

Таблиця 6. Частота ускладнень післяпологового періоду

Показник	Група обстежених					
	Основна, n= 40		Порівняння, n= 40		Контрольна, n = 50	
	абс.ч.	%	абс.ч.	%	абс.ч.	%
Порушення інволюції матки	6	15,0*	5	12,5	2	4,0
Порушення лактації	5	12,5	4	10,0	4	8,0
Гнійно-септичні ускладнення	4	10,0*	3	7,5	1	2,0
Пізня кровотеча	8	20,0*#	2	5,0	1	2,0

Примітки: * - різниця достовірна щодо показника жінок контрольної групи (p<0,05);
- різниця достовірна щодо показника жінок групи порівняння (p<0,05).

У основній групі відмічено 1 випадок антенатальної смертності, народилось 39 живих дітей. У групі порівняння та в контрольній групі випадків перинатальної смертності не відмічено, народилось 40 та 50 живих дітей відповідно.

Аналіз розподілу дітей по групах за станом при народжені показав, що майже половина дітей основної групи народилась в асфіксії різного ступеня тяжкості (48,7% проти 27,5 та 8,0% у групах порівняння та контрольній відповідно, p<0,05), при цьому у 10,3% діагностована тяжка асфіксія (проти 2,5% у групи порівняння, p<0,05), у контрольній групі випадків тяжкої асфіксії не відмічено.

Розподіл за масою дітей жінок, що перенесли ВПХВ, також мав свої особливості. Так, майже третина дітей народилась з масою тіла нижче 2500 г, що суттєво вище відповідної частки як серед дітей від жінок контрольної групи, так і групи порівняння (30,8% проти 4,0 та 12,5% відповідно, p<0,05), що обумовлено як високою частотою передчасних пологів, так затримкою внутрішньоутробного розвитку.

У 74,4% новонароджених від матерів основної групи відмічені різноманітні порушення періоду ранньої неонатальної адаптації (проти 45,0% у групі порівняння, p<0,05), серед яких найбільше виділялись (табл. 7): РДС (35,9% проти 15,0 та 2,0% у групі порівняння та контрольній групі, p<0,05), жовтяниця (43,6% проти 17,5 та 8,0%, p<0,05) та гастроінтестінальний синдром (30,8% проти 15,0 та 6,0% відповідно, p<0,05). Звертає на себе увагу підвищена у 2 рази відносно групи порівняння частота геморагічного синдрому (17,9 проти 7,5%, p>0,05).

Таблиця 7. Особливості перебігу раннього неонатального періоду

Показник	Група обстежених					
	Основна, n= 39		Порівняння, n= 40		Контрольна, n = 50	
	абс.ч.	%	абс.ч.	%	абс.ч.	%
Порушення періоду адаптації	29	74,4*#	18	45,0*	2	4,0
Втрата маси тіла більше 10%	21	53,8*	15	37,5*	1	2,0
РДС	14	35,9*#	6	15,0*	1	2,0
Неврологічні порушення	12	30,8*	8	20,0*	3	6,0
Гастроінтестінальний синдром	12	30,8*#	6	15,0	3	6,0
Жовтяниця	17	43,6*#	7	17,5	4	8,0
Геморагічний синдром	7	17,9*	3	7,5	1	2,0

Примітки: * - різниця достовірна щодо показника дітей контрольної групи (p<0,05);
- різниця достовірна щодо показника дітей групи порівняння (p<0,05).

Висновки. У більшості (62,5%) пацієнток після ДРТ діагноз ВПХВ встановлено після 30 тижнів вагітності, у інших (37,5%) – від 24 до 30 тижнів. Деякі пацієнтки (27,5%) відмічали короткочасні епізоди проявів ВПХВ до 24 тижнів вагітності. У 7 (17,5) жінок ВПХВ мав тяжкий перебіг.

Майже третина (27,5%) жінок старших за 35 років (проти 12,5% без ВПХВ, p<0,05). У жінок з ВПХВ суттєво вища частота алергії в анамнезі (35,0% проти 17,5% відповідно, p<0,05), патології печінки (20,0% проти 7,5, p<0,05) та захворювань ШКТ (25,0% проти 10,0, p<0,05).

У третини жінок ВПХВ розвинувся повторно, 42,5% пацієнток основної вказували на обтяжений по ВПХВ сімейний анамнез, що свідчить про спадкову обумовленість захворювання. Майже третина жінок (27,5% проти 12,5%, p<0,05) мали в анамнезі синдром полікистозних яєчників (СПКЯ).

Теперішня вагітність протікала з високою частотою ускладнень. У чверті пацієнток (25,0%) спостерігався ранній гестоз. У II половині вагітності у більшості жінок при маніфестації ВПХВ відмічено загрозу передчасних пологів (60,0% проти 32,5% у групі порівняння, p<0,05). Частота дистресу плода у жінок з ВПХВ була майже у 2 рази вищою ніж у пацієнток без цього ускладнення (47,5% проти 25,0% відповідно, p<0,05). Вища також і частота прееклампсії (40,0% проти 22,5%, p<0,05).

Переважна більшість жінок основної групи розроджена шляхом кесаревого розтину (70,0% проти 52,5% пацієнток групи порівняння, p>0,05). Передчасними були пологи майже у половини

пацієнток з ВПХВ (45,0% проти 20,0% у групі порівняння, p<0,05). У третини жінок (35,0% проти 17,5%) відмічено дистрес плода в пологах. У 27,5% проти 12,5% пологи ускладнились кровотечею більше 5% маси тіла, що може бути зумовлено дефіцитом вітаміну К, характерним для ВПХВ. Післяпологовий період у пацієнток основної групи характеризувався збільшеною у 4 рази відносно групи порівняння частотою пізніх кровотеч (20,0% проти 5,0%, p<0,05).

У вагітних після ДРТ з ВПХВ відмічено один випадок антенатальної смертності. Майже половина дітей народилась в асфіксії різного ступеня тяжкості (48,7% проти 27,5%, p<0,05), при цьому у 10,3% діагностована тяжка асфіксія (проти 2,5%, p<0,05). Третина дітей народилась з масою тіла нижче 2500 г (30,8% проти 12,5%, p<0,05), що обумовлено як високою частотою передчасних пологів, так затримкою внутрішньоутробного розвитку.

У 74,4% новонароджених від матерів основної групи відмічені різноманітні порушення періоду ранньої неонатальної адаптації (проти 45,0%, p<0,05), серед яких найбільше виділялись: РДС (35,9% проти 15,0%, p<0,05), жовтяниця (43,6% проти 17,5%, p<0,05) та гастроінтестінальний синдром (30,8% проти 15,0, p<0,05). Звертає на себе увагу підвищена у 2 рази частота геморагічного синдрому (17,9 проти 7,5%, p>0,05).

Автори заявляють про відсутність конфлікту інтересів.

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ENGINEERING SCIENCES

МИКРОТВЕРДОСТЬ ЧАСТИЦ ПОКРЫТИЯ ПРИ ЭЛЕКТРОДУГОВОМ НАПЫЛЕНИИ С ПУЛЬСИРУЮЩИМ РАСПЫЛЯЮЩИМ ПОТОКОМ

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7445

ARTICLE INFO

Received: 05 December 2020
Accepted: 10 February 2021
Published: 28 February 2021

KEYWORDS

micro-hardness, non-metallic inclusions, liquid inclusions, liquid metal, electrode, electric-arc sputtering, pulsating jet, coating, air consumption, pulsating supply, sputtered coating.

ABSTRACT

Intense oxidation of sputtered metal happens to be at electric-arc sputtering, due to oxygen, contained in the air, it leading to drastic reduction of the content of alloying elements in the coating.
This work contains a method of evaluation of micro-hardness of the particles of the coating, deposited with pulsating air supply into the area of electrodes melting by introducing an additional element into the spraying head of the electric-arc metallizator Also performed was estimation of the amount of non-metallic inclusion. Also included are the results of alternations in particles micro-hardness, depending upon the frequency of pulsations at EAM with application of a pulsating spraying jet.

Citation: Vyacheslav Royanov, Mykyta Kriuchkov, Irina Zakharova, Vladimir Matviyenko. (2021) Micro-hardness of the Particles of Coating at Electric-arc Sputtering with Pulsing Jet Spraying. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7445

На кафедре «Автоматизация и механизация сварочного производств» ГВУЗ ПГТУ предложено использование пульсирующего распыляющего потока при электродуговом напылении. В работах [1, 2, 3] представлен принцип метода, характеристики оборудования для обеспечения пульсаций распыляющего потока, формы и длительности импульсов, воздействие потока на распыляемый материал. Снижение воздействия кислорода воздуха на жидкий металла электродов при электродуговом напылении с пульсирующей распыляющей струей на массоперенос металла приведены в работах [5].

В работе [2, 4] показано положительное влияние на снижение уровня окисления распыляющего материала и повышение содержания легирующих компонентов в покрытии – например M_n, S_i, C. Отмечено повышение производительности процесса и эффективности использования материала и вероятность снижения оксидной фазы на границе частиц в покрытии. Свойства частиц, в частности микротвердость не исследовано. В то же время микротвердость связана со всеми механическими характеристиками, и ее измерение позволяет оценить прочностную однородность напыленного слоя.

Изложение основного материала. Микротвердость и микроструктуру покрытий исследовали на образцах, полученных электродуговой металлизацией с использованием пульсатора, который обеспечивает частоту пульсаций в пределах 0 – 120 Гц. В качестве материала основы использовали сталь типа Ст3, в виде пластин размером 100 × 100 × 7 мм. Перед напылением образцы обезжиривали сольвентом и подвергали дробеструйной обработке с последующей обдувкой сжатым воздухом (для удаления пыли). Напыление проводили с помощью металлизатора ЭМ-17 с разработанным авторами устройством пульсирующей подачи воздуха, с применением проволоки 08Г2С. Напыление производили по следующим режимам для проволоки 2мм. Давление воздуха 0.6 Мпа, расход воздуха 2.5 м^3/мин, ток дуги 180-220 А, напряжение 28-30 В.

Химический состав проволоки: C 0.05-0.15, Si 0.7-1, Mn 1.5-2.3, Ni до 0.3, S до 0.025, P до 0.03, Cr до 0.3, Cu до 0.3, As до 0.08.

Производилось напыление с оптимального расстояния равного 170мм строго под углом 90 градусов. Чтобы не было перегрева покрытия. Для этого напыление производилось в несколько этапов. Напылялся слой толщиной около 0.5 мм с дальнейшим его остыванием до окружающей температуры, и так минимум 5 раз.

После напыления, вырезается заготовка размером 30х30 мм, шлифуется наждачным камнем и наждачной бумагой мелкой фракции с последующей полировкой.

Измерения микротвердости производили из участка в центре, откуда брали 8 точек для каждой частоты пульсации.

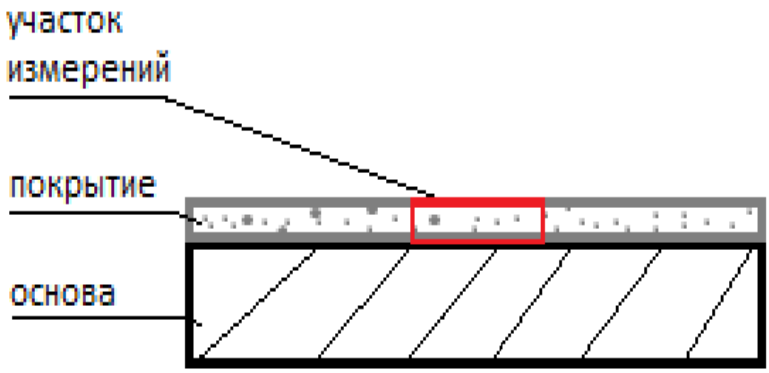

Рис.1. Схема выбора образца для снятия измерений

С помощью миллиметровой бумаги, учитывая масштаб снимков и разметку микротвердомера, определили относительное содержание оксидов на данных участках измерений по формуле

$$N = \frac{F_{\text{пок}}}{F_{\text{н.м}}} \times 100\%,$$

где $F_{\text{пок}}$ – площадь общая по снимку

$F_{\text{н.м}}$ – площадь не металлических включений

Таблица 1. Процентное содержание не металлических включений к площади снимка

Частота Гц	%
0	9.4
30-35	5.6
65-70	2.3

Измерения производились на микротвердомере ПМТ-3 с нагрузкой 100 грамм. Увеличение 400х. На рисунках не трудно усмотреть, что между частицами и слоями наблюдаются границы из оксидных пленок. Твердость частицы измерялась путем замера длины диагонали пирамидки. Расчетные данные сведены в таблице 1 для частот, на которых производили измерения.

Таблица 2. Значения микротвердости на выбранном участке покрытия в единицах измерения H_D

№	Без частоты H_D/H_{Rc}	Частота 30-35 Гц H_D/H_{Rc}	Частота 65-70 Гц H_D/H_{Rc}	Частота 105 Гц H_D/H_{Rc}
1	301/31	317/33	301/31	325/34
2	294/30.2	309/32	309/32	325/34
3	287/29.3	294/30.2	317/33	294/30.2
4	280/29.4	294/30.2	325/34	317/33
5	325/34	325/34	325/34	309/32
6	325/34	325/34	317/33	301/31
7	317/33	317/33	334/35	280/29.4
8	309/32	309/32	325/34	309/32

Микроструктура участка покрытия без травления, полученная без воздействия пульсатора на воздушно – распыляющую струю с использованием цельной проволоки представлена на рисунке 2.

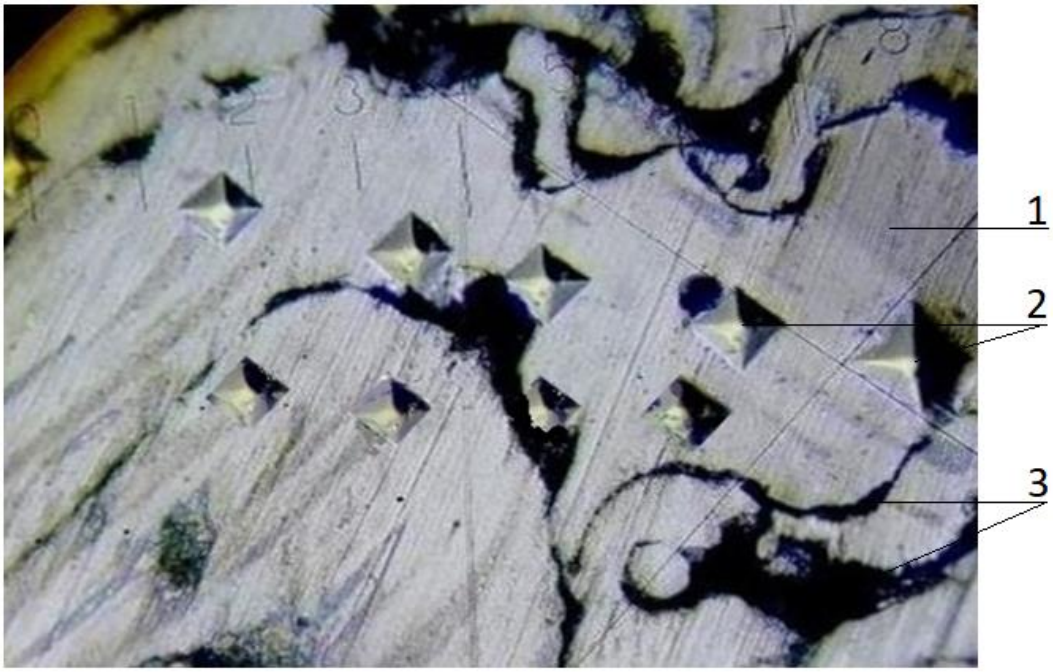

Рис.2. Микроструктура образца без использования пульсатора увеличение 400х (1- металл частицы, 2- точки воздействия твердомера, 3- границы между частицами)

При увеличении в 400х не трудно усмотреть, что между частицами и слоями наблюдаются границы из оксидных пленок и не металлические включения структура покрытия неоднородна, с большим количеством частиц различной формы.

На рисунке 3 представлено строение и замеры с частотой пульсации 30-35 Гц. Так при данной частоте отмечается существенное изменение формы напыляемых частиц и количество не металлических включений по сравнению с покрытием без пульсаций. Частицы имеют меньшие размеры по сравнению с образцами, выполненными без пульсаций.

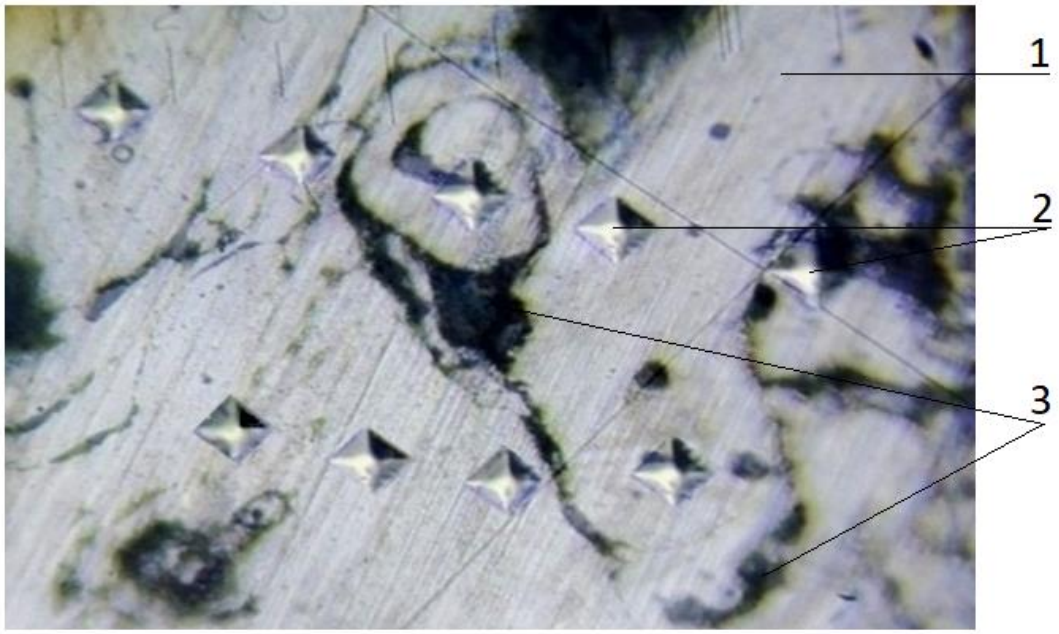

Рис.3. Структура участка покрытия с использованием пульсирующей воздушной струи 30-35 Гц при увеличении 400х (1- металл частицы, 2- точки воздействия твердомера, 3- границы между частицами)

На рисунке 4 представлено покрытие при частоте 65-70 Гц отмечается увеличение количества частиц малых размеров на ряду с крупным. Средний размер частиц колеблется в пределах 50 – 350 мкм. Это объясняется тем, что промежуток в следовании импульсов воздушно – распыляющей струи имеет меньшую по времени величину для накопления жидкого металла на торцах электродов.

Образования жидкого металла на торце имеет большее по продолжительности время, чем временной промежуток в следовании воздушно – распыляющего потока при данной частоте, что увеличивает усилие сброса жидкого металла с торцов электродов силой распыляющего потока.

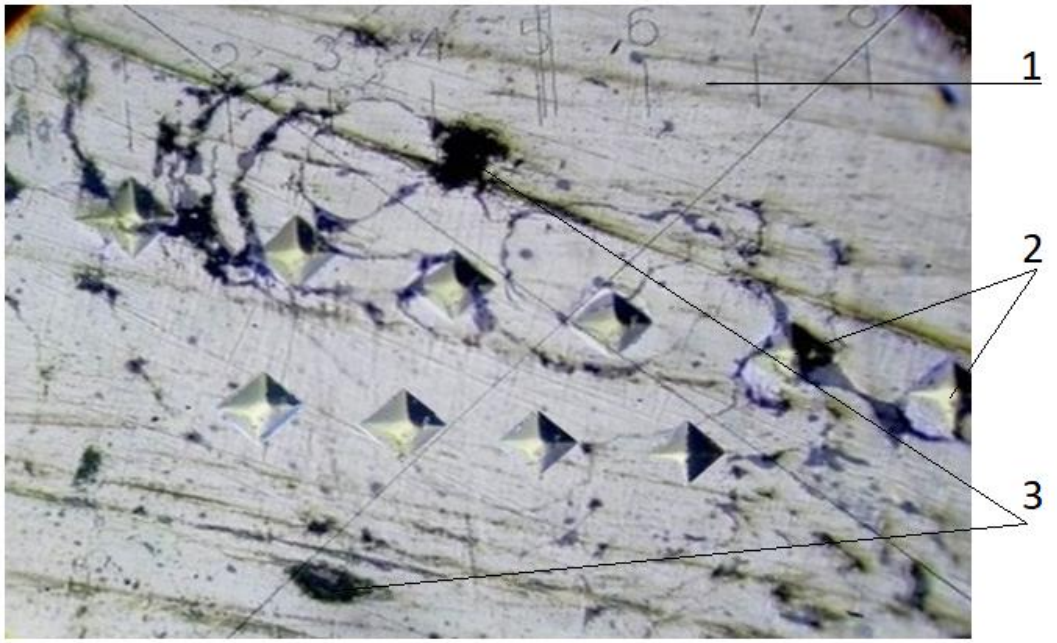

Рис.4. Структура участка покрытия с использованием пульсирующей воздушной струи 65-70 Гц при увеличении 400х (1- металл частицы, 2- точки воздействия твердомера, 3- границы между частицами)

Измерение микротвердости показывает, что с увеличением частоты пульсаций распыляющей струи микротвердость покрытия не значительно увеличивается.

На образце напыленном с помощью пульсирующего метода, микротвердость не много выше. Это происходит за счет уменьшения выгорания легирующих элементов. При замерах не металлических включений микротвердость достигала 15.1 - 18.4 H_{Rc}. И чем их больше, тем самым общая микротвердость покрытия ниже.

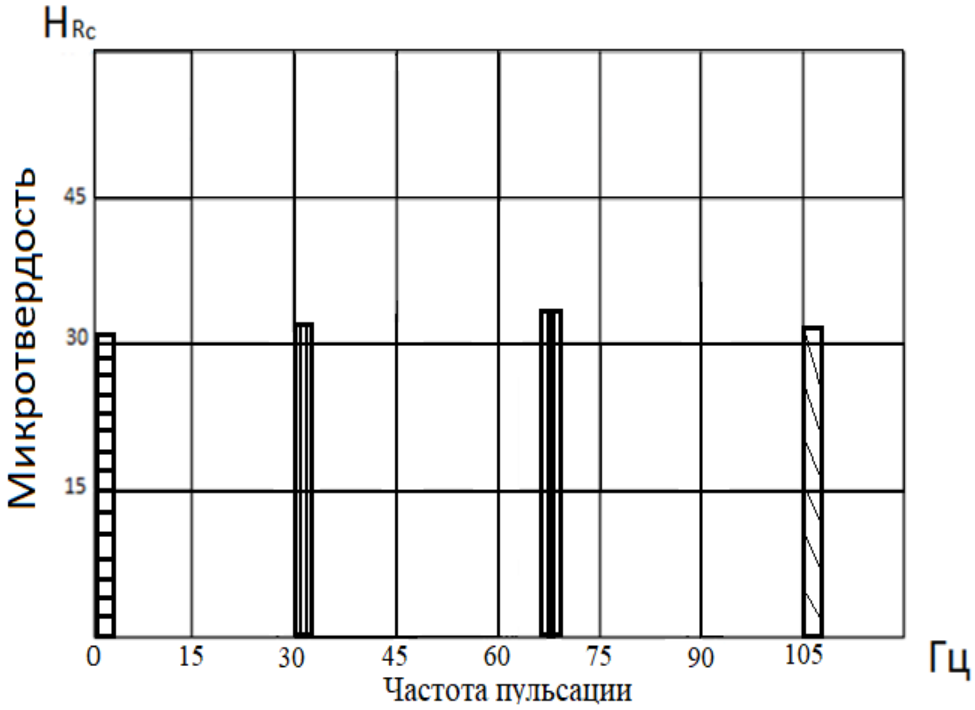

Рис.5. График изменения микротвердости частиц в зависимости от частоты пульсаций распыляющего потока

Результаты исследования обобщены на рисунке 5. Таким образом показали, что при использовании метода напыления с пульсирующим воздушным потоком с оптимальной частотой 65 -70 Гц, микротвердость покрытия увеличивается на 6%.

Выводы.

1. При использовании пульсирующего распыляющего потока наблюдается увеличение микротвердости покрытия на 2.7% при частоте 30 – 45 Гц и на 6 % при частоте 65- 70 Гц. При дальнейшем росте частоты, существенного увеличения твердости не наблюдается.

2. При использовании пульсирующей струи с частотой оптимальной 65-70 Гц наблюдается значительное снижение не металлических включений по границам частиц на 3.8% при частоте 30-45 Гц и на 7.1% при 65-70 Гц.

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МНОГОФАКТОРНОЕ МАТЕМАТИЧЕСКИ-СТАТИСТИЧЕСКОЕ МОДЕЛИРОВАНИЕ НЕФТЯНОГО ПРОИЗВОДСТВА

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7446

ARTICLE INFO

Received: 11 December 2020
Accepted: 10 February 2021
Published: 28 February 2021

KEYWORDS

oil, gas, industry, reserves, resources, deposit, expenses per a production unit, mathematical statistics, theory of probability, location of oil and gas industry, statistical criterion, adequacy, location of oil and gas industry.

ABSTRACT

Oil and gas deposits differ depending on the bed size, geological-physical development conditions, oil quality and geographic location. Including them in the development is connected with various investments to the main constructions; subsistence and current material expenses also differ. Therefore, from the point of view of economic efficiency, oil and gas deposits are not equal. Location of oil and industry leads to the problem of the sequence of putting of various deposits into operation and their development rate. The sizes of oil and gas beds and available oil and gas reserves in them give reason to say which of these beds will be put into operation in the near future. Completion and development of large scale deposits require less investments compared to small scale deposits. Such deposits are usually highly productive, expenses per a production unit in them is small. All these determined importance of the use of reserves in large scale deposits in the first turn.

Citation: Gunay Vagifgizi. (2021) Multi-factorial Mathematical Statistical Simulation of Oil Production. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7446

Введение. Современное развитие нефтегазовой промышленности и увеличение запасов вязкой нефти, нахождение ее в очень плохих геолого-физических условиях на глубине, в глубокой части моря, связанная с этим необходимость больших капиталовложений, требует применения в нефтедобыче новой техники и технологий. Правильное проведение экономической дифференциации запасов в таких месторождениях снижает качество обоснования планирования на долгую перспективу отрасли нефтегазовой промышленности, усложняет установление потребности в материальных, финансовых и трудовых ресурсах с точки зрения производственно-ресурсного потенциала (ПРП) нефтегазовой добычи.

Целью геолого-экономического оценивания нефтяных запасов и ресурсов является дифференциация их основных природно-географических, горнотехнических и геолого-технологических условий разработки, что приводит к определению технико-экономических показателей разработки и совокупных затрат на производство нефти.

Чрезмерное прерывание сети скважин, низкий темп и объем бурения, отсутствие должного масштаба воздействия от полива пластов и других методов, постоянное ухудшение горно-геологических условий разработки не позволило стабилизировать и повысить производство нефти по Производственному Объединению «Азнефть» и его нефтегазодобывающим предприятиям.

Классификация запасов и ресурсов и геолого-экономическое обоснование, параллельно с количественным оцениванием сырьевой базы, является основой мероприятий по перспективному планированию производства нефти, увеличению запасов, определению объема и направления геологоразведочных работ, а также по научно-техническому прогрессу.

Методология исследования. В проведении исследовательской работы широко использованы методы системного подхода, геолого-экономическая классификация

нефтегазовых запасов и ресурсов, сравнительного анализа, группирования, математически-статистического моделирования, теории вероятностей и «тренд»-моделирования, дана экономическая интерпретация полученных моделей, с помощью статистических критериев проверена их адекватность.

Результаты исследования. Уровень современного развития нефтегазовой промышленности требует увеличения темпа подготовки ее сырьевой базы. Поэтому установление эффективного соотношения между запасами готовой нефти и уровнем производства определяет возможности увеличения ПРП нефтегазодобывающего предприятия, и эта проблема до сих пор не нашла своего решения. Но ясно то, что эффективный уровень обеспечения запасами нефтегазовой промышленности, при неизменных прочих условиях, требует повышения интенсивности геологоразведочных работ в стране. Таким образом, высокий уровень обеспечения запасами приводит к замораживанию финансовых и трудовых ресурсов, затраченных на создание этих запасов в имеющейся финансово-технической базе нефтегазодобычи; низкий же уровень приводит к неэффективному использованию этих ресурсов.

С возникновения этой проблемы до сегодняшнего дня обеспечение запасами определяли делением уровня запасов нефти и газа в начале года на объем планового производства в том же году. Таким образом, этот показатель можно определить в любое время. Но по различным геологическим, технико-технологическим и экономическим факторам, в качестве оценки этот критерий использован быть не может. Другими словами, при сравнении показателей в разных регионах возможностей развития нефтегазовой добычи с точки зрения ПРП использование этой величины привело бы к неверным результатам. Таким образом, практика показывает, что между обеспечением запасами и производством практически нет точной установленной зависимости.

Показатель «разовости» (т.е. во сколько раз больше), выражающий соотношение нефтегазовых запасов и производства, меняется в очень широком диапазоне. Дело в том, что, когда нефтегазовое месторождение является предметом торговли, показатель «разовости» может стать орудием манипуляций при конкурентноспособности, формировании цены на нефть, одним словом, при реализации определенных дурных целей. В результате анализа выяснилось, что коэффициент «разовости» запасов меняется в широком диапазоне: 8.4÷262.4. Это означает, что между возможными остаточными нефтезапасами и объемом производимой нефти нет соответствия определенному закону. Кроме того, коэффициент «разовости» не определяет и себестоимости нефтегазового производства. В близких значениях этого показателя, т.е. 22.5÷24.1, в нефтегазодобывающих предприятиях объем производства составляет соответственно 1032.1÷446.5 тысяч тонн.

Темп изменения показателя «разовости» запасов и производства не соответствует практике. Независимость этих величин ясно видна на примере разработки различных месторождений. Кривая изменения коэффициента «разовости» напоминает параболу, причем ее концы направлены вверх, а минимальное значение характеризует максимум нефтепроизводства.

Известно, что соответствие изменения показателя «разовости» определенному закону зависит от уровня исследования района нефтегазовой добычи страны.

Разделение районов нефтегазодобычи на степени исследования основывается на нескольких количественных и качественных показателях. Важнейшим информативным количественным показателем, характеризующим степень исследования, является соотношение между различными запасными категориями. Учитывая коэффициент исследования, а также развитие района нефтегазовой добычи, эффективность, достигнутую в геологическом исследовании и поисковых работах, можно провести дифференциацию по подтвержденной нефтегазовости районов.

Учитывая вышесказанное, мы предлагаем «тренд» модель возможных нефтезапасов, т.е. изменение по времени. Компьютерная обработка данных по возможным остаточным нефтезапасам (ОНЗ) за несколько лет порождает следующую «полиномиальную» тренд модель:

$$ОНЗ = - 2831\ T^2 + 13542\ T + 14397 \quad (1)$$

$R^2 = 0.562$

Значение коэффициента детерминации ($R^2 = 0.562$) соответствует среднему уровню зависимости от времени возможных нефтезапасов.

Нефтегазовые запасы – один из основных элементов ПРП в нефтегазовой добыче, и эффективное использование этих запасов в конечном счете приводит к росту объема производства.

В современном мире увеличение производства нефти повышает важность научно-технического прогресса и потому направлено на повышение эффективности отрасли промышленности и улучшение экономических показателей.

Также необходимо отметить, что нефтяная промышленность достигла высокого уровня научно-технического прогресса, и ее дальнейшее развитие ставит перед собой новые требования. Эти требования подразумевают применение био- и нанотехнологий, эксплуатацию «умных» шахт, использование элементов цифровой экономики в эксплуатации скважин.

Использование всех возможностей ПРП в нефтегазовой добыче в конечном счете служит реализации объема конкурентноспособного производства, обуславливает его устойчивость в том или ином сегменте рынка.

Факторы, определяющие изменение производства нефти, следующие: усовершенствование применения метода полива, усовершенствование способов производства нефти, расширение применения методов, влияющих на зону дна скважины, включение в эксплуатацию новых скважин, освоение возможных запасов при максимально выгодном использовании естественных условий в разработке месторождения, улучшение применения новой техники и технологий в производстве нефти.

В нефтегазовой добыче с точки зрения реализации ПРП важное значение имеют моделирование нефтепроизводства, анализ статистических показателей полученной модели, определение ее адекватности и экономическая интерпретация. С учетом сказанного мы предлагаем следующее моделирование ежедневного нефтепроизводства (ЕП) и в общем нефтепроизводства (НП). Тренд-модель изменений по времени ежедневного нефтепроизводства следующая:

$$ЕП = 1.621T^2 – 8.278T + 24.16 \quad (2)$$

$R^2 = 0.927$

Как видно из модели, коэффициент детерминации, характеризующий «тренд», очень высок. ($R^2 = 0.927$).

Известно, что на объем нефтепроизводства влияет много факторов. Отбор из них наиболее влияющих на нефтепроизводство факторов является сложной задачей. При этом в литературе [1–5] рассмотрены факторы, влияющие на нефтепроизводство.

На основе литературы и априорного анализа было установлено, что объем нефтепроизводства (НП) связан со следующими факторами: возможные запасы (X_1), фонд эксплуатационных скважин (X_2), коэффициент эксплуатации (X_3). Найдены коэффициенты корреляции между аргументом (НП) и факторами (X_i). Было обнаружено, что за исключением Γ_{YX_3} и $\Gamma_{X_2X_3}$, корреляционная связь между другими факторами слабая. Это обусловлено тем, что в этой модели данные месторождений на море и суше были рассмотрены вместе. Естественно, что запасы этих месторождений, объемы производства, затраты на продукт и другие показатели различаются, и это проявляется в адекватности полученных моделей.

Компьютерная реализация представляет собой следующую многофакторную математически-статистическую модель нефтепроизводства (НП):

$$НП = 38890.89 – 0.022857X_1 – 1.3353297X_2 – 21153.1719X_3 \quad (3)$$

Анализ статистических показателей модели показывает, что коэффициент общей корреляции равен: R = 0.9865, т.е. очень высок. Значение стандартной погрешности (S_R) находится в указанных пределах.

В общем для оценки модели используется коэффициент Фишера F. Если отчетное значение коэффициента Фишера ($F_{отч.}$) больше его критического (табличного) значения ($F_{крит.}$), то модель адекватна. В нашей модели критическое (табличное) значение коэффициента Фишера F с вероятностью 95% равно: $F_{крит.} = 3.62$. Отчетное значение этого показателя ($F_{отч.}$) равно: $F_{отч.} = 12.065$, т.е. условие $F_{отч.} > F_{крит.}$ удовлетворяется.

Что же касается оценивания различных факторов модели, эта задача решается использованием коэффициента t-Стьюдента. А именно, у коэффициента t-Стьюдента есть критическое (табличное) значение и оно с вероятностью 95% равно: $t_{крит.} = 2.57$. Анализ

показывает, что отчетные значения X_i не превышают критического (табличного) значения t-Стьюдента, т.е. условие $t_{отч.} > t_{крит.}$ не удовлетворяется. Причину этого мы указывали выше, т.е. совместное использование данных месторождений на море и суше.

Анализ показывает, что отчетное значение показателя Р-важности с вероятностью 95% меньше 0.05, а это свидетельствует о важности соответствующего коэффициента модели.

При компьютерной обработке с вероятностью 95% были найдены коэффициенты достоверности, показаны их верхний и нижний пределы. Выяснилось, что это условие полностью удовлетворяется как для результата (НП), так и для воздействующих факторов (X_i), что показывает адекватность модели.

Результаты. Моделирование объема нефтепроизводства, как один из элементов выявления ПРП нефтегазовой добычи, показывает возможности в этой области. Другими словами, используя для увеличения статистических показателей модели объема производства фонд скважин, технику и технологии, время эксплуатации, наконец, правильную организацию объемного производства запасов, можно увеличить ПРП предприятия нефтегазовой добычи. Воплощение этих работ повысит ПРП предприятий нефтегазовой добычи, Производственного Объединения «Азнефть» и SOCAR, сделает эти предприятия более конкурентноспособными.

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ON ONE APPROACH OF FORECASTING NATURAL DISASTERS WITH THE SYSTEM OF PATTERN RECOGNITION WITH LEARNING

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7447

ARTICLE INFO

Received: 19 December 2020
Accepted: 13 February 2021
Published: 28 February 2021

KEYWORDS

System, Model, Knowledge and data bases, Pattern recognition, Natural disaster.

ABSTRACT

There are a number of recognition problems in different fields that can be solved with the system of pattern recognition with learning – SPRL elaborated by us. The problem of forecasting natural disasters (floods, mudslides) in the given year, the fixed region, and the period belongs to it. To solve it, it is set in the terms of pattern recognition with learning according to which it is necessary to pre-determine the learning descriptions in the same region of the previous years using data of the previous 12 months of the period. From learning descriptions, firstly are separated control descriptions, then the variants of learning and learning recognizable descriptions. Besides, it is necessary to determine descriptions in year, in the same region using data of the same previous period of the (the first model). After transformation and increasing the informativity of the learning descriptions, the knowledge and data bases are determined for learning recognizable and control descriptions in relation to the variants and classes (the second model). Using them, one decision is made on belonging to the respective class for learning recognizable descriptions, but for control descriptions – the primary decisions according to the number of variants, and then on their basis – one decision. Exactly according to the results of the recognition of control descriptions a decision is made on the occurrence (non-occurrence) of a natural disaster in the same region and period (the third model). The article discusses the arguments related to this fact. This model considers the correction of data bases with respect to variants and classes, also, defines the effectiveness of working of the SPRL and its detector of trust. Considering the specifics of forecasting, the initial data of at least 5 years are required to select the best knowledge and data bases with the use of which a disaster should be forecasted.

Citation: Nelly Tkemaladze, Giorgi Mamulashvili. (2021) On One Approach of Forecasting Natural Disasters with the System of Pattern Recognition with Learning. *World Science*. 2(63). doi: 10.31435/rsglobal_ws/28022021/7447

Introduction. Pattern recognition is one of the priority areas of cybernetics in which the objectives of pattern recognition with learning occupy an important place. Forecasting of natural disasters (floods, mudslides) is also a significant problem. To solve it with the system of pattern recognition with learning – SPRL [1,2] elaborated by us, we have to set it in the terms of pattern recognition with learning.

Suppose we have the description corresponding to the phenomenon belonging to two classes (we mean occurrence and non-occurrence of natural disasters). From these descriptions, let us call the first class the set of such descriptions which correspond to the fact of occurrence of a natural disaster,

and the second class – to the fact of non-occurrence of disasters. To predict whether a natural disaster will occur or not in the given year t_o, region, and time period T_0, it is necessary to have learning descriptions previously determined based on the data of the previous 12 months of the period T_0 in this region in other years. Based on these learning descriptions, such knowledge and data bases should be determined for each class which can be used to recognize, for example within the accuracy of a 30-day period, in the year t_o, (as well as in other years) whether the same natural disaster will occur or not in the same fixed region and the given time period T_0. Based on the aforementioned, to solve this problem, i.e. to predict a natural disaster, it is necessary to determine the initial learning descriptions in advance. Moreover, the recognizable descriptions determined on the basis of the data of the previous 12 months of this year t_o, in the same region and the period T_0 should be recorded in the same codes, i.e. in the "language" in which the learning descriptions will be recorded.

Learning descriptions and their transformation. In the case of objects, a learning description [3,4] is a sequence of the parameter values – features characterizing the object, for which the class the object represented by this sequence belongs to is known in advance. The sequence of parameter values – description is also called a realization [1,5]. It is a vector with m components, m – is the number of parameters. In the case of a natural disaster, the fact of occurrence or non-occurrence of this phenomenon must be known in the fixed region and the given period T_0. In such a case, let us call this period a learning zero block. The sequence of values of the characteristic parameters of the phenomenon in the period of the previous 12 months corresponding to this learning zero block T_0 in relation to each month and region in case of occurrence or non-occurrence of a disaster will be called learning description.

Thus, to recognize objects as well as to forecast a natural disaster (phenomenon) with the system of pattern recognition with learning – SPRL [1,2], it is necessary to have appropriate learning descriptions in advance.

The SPRL is implemented on a personal computer and on the basis of the real data is verified to recognize objects of different classes: satellites, airplanes, helicopters, and also their types, for the classification of irises, etc. The system contains: 1) the model of preliminary elaboration of the initial information, 2) the learning model, and 3) the recognition model. The first two models include the methods and algorithms of solving 7-7 objectives, and the third model – of solving 8 objectives.

This system can also be used to forecast a natural disaster taking into consideration its specificity. This means that it will be possible to forecast whether a natural disaster is expected or not in the given year, in the fixed region, and in the given period of time T_0 (zero block). For this, it is necessary to know the data in the previous years in the same region and in the previous 12 months of the period T_0 (learning zero block). The data should be represented in the form of sequences of values of the relevant characteristic parameters of a phenomenon, i.e. descriptions. Under these data are meant the features (the values of the parameters) characterizing a phenomenon in the appropriate period, which may include the characteristic features determining occurrence and non-occurrence of natural disasters.

Besides, the system must preliminarily elaborate the data corresponding to the previous 12 months of the learning zero block i.e. such a zero block which is given in the previous years, corresponding to the same region and the same time T_0, in case of which the fact of occurrence, as well as non-occurrence of a natural disaster, is known in advance. Meanwhile, these data must be given in relation to the learning zero block of the given phenomenon in case of occurrence and non-occurrence separately. Hence, we must have the learning zero block and learning descriptions corresponding to the previous 12 months of this learning zero block in the previous years and the given region for each class separately.

It is on the basis of the data that learning descriptions should be determined by the method (proposed in the paper [6]), which will be included in the first model of the SPRL.

The method considers choosing the initial parameters, dividing each month from the previous 12 months of the learning zero block into small periods (learning blocks), dividing the 24-hour time interval into two intervals, determining primary, additional, and formal additional parameters. Based on the values

of these parameters, primary learning descriptions are determined for each class in relation to each month from the previous 12 months of the learning zero block, the learning blocks included in them, and the time intervals mentioned above. From them, using the vector-optimization method [7] such primary learning descriptions are chosen which belong to the Pareto set. The learning descriptions determined in this way are transferred to the sixth objective of the first model of the SPRL – the model of preliminary elaboration of the initial information. It uses random numbers to separate control descriptions from learning descriptions, and from the rest of the descriptions, using random numbers and slipping control procedure, determines the variants of learning recognizable and learning descriptions for both classes. Further, when we mention variants, we mean variants of learning recognizable or learning descriptions. Learning descriptions will be transferred to the learning model, which transforms these descriptions (included in the variants) in relation to the informativity. It is obvious that on the basis of the learning descriptions determined from the values of less informative parameters, it can be difficult and even impossible to determine such knowledge and data bases that can be used to forecast the appropriate natural disaster.

On the other hand, since these descriptions represent learning descriptions, it is therefore known whether the corresponding natural disaster occurred or not in the indicated learning zero block. It means that there must exist such reasons which condition the fact of occurrence (or non-occurrence) of this disaster. We must search these reasons in these internal hidden connections which really exist between the parameters characterizing the disaster in relation to the previous 12 months of the learning zero block in case of occurrence as well as non-occurrence of this phenomenon. These connections are not explicitly given in the mentioned learning descriptions. In order to define these connections, it is necessary to transform these descriptions. All procedures of this transformation that we use for learning descriptions in relation to the zero block are used for learning descriptions included in both classes, i.e. in the case of occurrence and non-occurrence of a disaster.

Based on the variants of the above-mentioned learning descriptions, the learning model already in relation to informativity, determines these connections – new formal (artificial) parameters, functions. For this, the learning model uses: balanced incomplete and partially balanced incomplete block-designs (*BIB*- and *PBIB(2)*- *d*esigns), i.e. (v,b,k,r,λ) and $(v,b,k,r,\ n_i\ ,\lambda_i\ ,P^i)$ $i=\overline{1,2}$ type configurations; (v,b,k,r,λ,μ) type tactical configurations [8,9]; geometrical configurations [10] and the vector-optimization method of choice [7]. Exactly thus determined parameters (also their values) show inner hidden connections between initial parameters (accordingly, between their values) [1]. To determine them, the method of solving the second objective of the learning model is used. According to this method, for example, in the case when we have p_j, $j=\overline{1,7}$ the number of parameters, with the values of which are defined learning descriptions, we should determine the configuration $(7,7,4,4,1)$, i.e. symmetric *BIB*-design with parameters: $v=b=7,\quad k=r=4,$ i.e.

$(p_{1,},p_2,\ p_4);(p_{2,},p_3,\ p_5);(p_3,p_4,\ p_6);(p_{4,},p_5,\ p_7);(p_5,p_6,\ p_1);(p_6,p_7,\ p_2);(p_{7,},p_1,\ p_3)$.

Let us call it primary *BIB*-design and its blocks – primary blocks. If we enumerate primary blocks and from them determine configuration with the same parameters (7, 4, 1), we will get the following secondary *BIB*-design, i.e.:

$((p_{1,},p_2,\ p_4);(p_{2,},p_3,\ p_5);(p_4,p_5,\ p_7)).\ ((p_{2,},p_3,\ p_5);(p_3,p_4,\ p_6);(p_3,p_6,\ p_1)).\ ((p_{3,},p_4,p_6);$

$(p_4,p_5,\ p_7);(p_{6,},p_7,\ p_2)).\ ((p_4,p_5,\ p_7);(p_{5,},p_6,\ p_1);(p_7,p_1,\ p_3)).\ ((p_5,p_6\ ,\ p_1);(p_{6,},p_7,\ p_2);$

$(p_1,p_2,\ p_4)).\ ((p_{6,},p_7,\ p_2));(p_7,p_1,\ p_3);(p_{2,},p_3,\ p_5)).\ ((p_7,p_1,\ p_3);(p_1,p_2\ ,\ p_4);(p_{3,},p_4,\ p_6)).$

Each block, i.e. extended block of the secondary *BIB*-design contains 3 primary blocks. Such extended blocks are separated from each other with two brackets and a dot. Each learning description is transformed into thus determined secondary *BIB*-design. It means that in each primary block will be recorded the values of the parameters given in it from each learning description in relation to the variants and classes. Therefore, each extended block can be represented as a geometrical configuration. In our case, i.e., when $K = 3$, it is represented as a triangle whose vertex coordinates will be the values of the parameters included in each primary block. Artificial parameters are determined by means of geometrical configurations (triangles). They can be trigonometric functions, their combinations median ratios, etc., even heuristically determined functions, i.e. all those functions

– formulas that characterize geometrical configurations and at the same time show connections between their vertex coordinates.

When a geometrical configuration is a triangle, whose vertex coordinates are the elements *(A, B, C)* of an extended block, the primary blocks $A=(x_1,x_2,x_3)$, $B=(y_1,y_2,y_3)$, $C=(z_1,z_2,z_3)$, some functions (artificial parameters) determined by means of this geometrical configuration look as follows:

$$P_1=(b^2+c^2-a^2)/2bc;\ P_4=((p-b)(p-c)/\ p(p-a))^{1/2};$$
$$P_7=(a+b)/c;\quad P_{10}=(y_3-z_3)/((x_1-y_1)^2+(z_2-y_2)^2)^{1/2},$$

where a, b, c are lengths of sides of a geometrical configuration, p – half of their perimeter. These functions show the connections between the parameter values given in the learning descriptions. They are determined in relation to all sides and angles of geometrical configurations for each variant separately. So, we determine the functions in relation to the extended blocks of the secondary $BIB-$design.

Thus, 7 triangles correspond to the above-mentioned secondary $BIB-$design. After this from the artificial parameters determined in relation to each side and angle of the triangles are selected those parameters whose one and the same meanings are contained if not in all, in most or at least in a certain number of learning descriptions included only in one and the same class. In case of necessity, parameters with large informativity measures can also be added to them. Determination of informativity measures of parameters is the function of the fifth objective of the learning model. From all parameters, determined this way the best parameters will be chosen separately for each class included in the corresponding variant. Singular as well as pair parameters whose values characterize only one, and meanwhile one and the same class are considered in the criterion of choice. After dividing the values of the selected parameters into intervals, they will be recorded in new codes – in a new "language" (the third objective of the learning model). From them, using the single and pair codes and with the help of the elaborated criteria, the best parameters will be chosen. Thus, the learning model transforms learning descriptions in relation to classes included in each variant this way.

Knowledge and Data Bases. After the transformation of the learning descriptions, they will be recorded in the new language in relation to the variants. This meant that the learning descriptions included in different variants will be recorded in the corresponding (different) “language”. Based on them, the relevant knowledge and data bases are determined. For each learning recognizable description, the knowledge base is determined on the basis of the learning descriptions included only in one corresponding variant and on the base of this knowledge base – one data base. For each control descriptions, knowledge bases are determined on the basis of the learning descriptions included in each variant taken separately from all variants. Thus, in this case, the knowledge bases of the number of these variants are obtained and on the basis of the knowledge bases – the same number of data bases. Consequently, knowledge and data bases of the number of these variants are obtained this way for each control description.

The knowledge base contains all the formulas (functions) as well as such values that are used for the transformation of the learning descriptions; it also contains the “language” in which will be recorded learning descriptions included in each variant.

The data base which is determined on the basis of the above-mentioned knowledge base, contains characteristics – parameter (function) values, i.e features of both classes, but separately for the first class and the second class: singular features, their pairs, triplets, and specific combinations of features (groups). These groups contain combinations of characteristic and non-characteristic features of classes. Triplets, as well as these combinations, are determined using the above-mentioned combinatorial schemes without an exhaustive search. Therefore, the number of triplets and these groups are significantly decreased, because of what it is possible to use them. At the same time, the learning model determines thresholds for each class separately on the basis of the sum of the informativity measures of features in relation to the variants and classes.

The data base, besides the above-mentioned characteristics (singular features, their pairs, triplets, specific combinations), also contains values that will estimate these characteristics. The following is implied in them: If a feature characterizes only one class, then it is called maximally informativity feature (mif), but the number of descriptions containing it is called the characteristic value of this feature; if a feature characterizes only one class and at the same time participates in all descriptions included in this class, we call maxmif (maximum maximally informativity feature); when a feature participates in

the descriptions of more than one class (but not in all descriptions included in all classes), then we call it an informative feature which is characterized by the informativity measure. The learning model calculates these measures based on the characteristics of such features which are not mif. The data base is determined separately for each class included in each variant of learning descriptions.

The process of transforming learning descriptions and determining knowledge and data bases is called the machine learning process. Thus, determined knowledge and data bases are passed to the recognition model.

Choice of knowledge and data bases and forecasting of natural disasters. As soon as the recognition model receives knowledge and data bases from the learning model, it will use the knowledge bases for the transformation of learning recognizable descriptions and control descriptions. In the first case, it will use the knowledge base determined on the basis of the learning descriptions included in the corresponding only one variant. In the second case, i.e. for each control description, the recognition model will use the corresponding knowledge base separately determined from all variants. Therefore, the learning recognizable descriptions included in each variant will be recorded in only one "language" in relation to classes. In the second case, each control description will be represented as the descriptions of the number of variants and will be recorded separately in the "language" given in the knowledge base corresponding to each variant, also in relation to classes.

The same will happen in the case of data bases. In the first case, i.e. to recognize each learning recognizable description, will be used the data base determined on the basis of one corresponding variant. In the second case, i.e. to recognize control descriptions, for each of them will be used the data bases of the number of variants also in relation to classes.

Thus, based on the aforementioned, in the first case, one decision is made to recognize each learning recognizable description. In the second case, for each control description, the primary decisions according to the number of variants of learning descriptions are made and then, on their basis – one decision is made [1]. The same will happen when instead of control descriptions we will have new recognizable descriptions determined on the basis of the previous 12 months in relation to the zero block. Thus, in this case, to recognize one and the same description are made the decisions that are made using knowledge and data bases determined according to the number of variants containing different learning descriptions. It is obvious recognition made on their basis will be more reliable than one decision made on the basis of one variant using only one knowledge base and data base.

In accordance with the characteristics included in the data bases, 5 types of criteria are used to make the primary decision: to make a decision with the first type of criterion, maxmifs of the appropriate class are used, with the second type of criterion – maxmifs and mifs, the third type – mifs, the fourth – mifs and the sums of informativity measures of features, the fifth – a threshold determined on the basis of informativity measures for each class and informativity measures [1]. Moreover, such values participate in these criteria which the recognition model needs to make the primary decisions, for example, a number of maxmifs, mifs, learning descriptions, etc.

The recognition model, using the appropriate criteria [1] based on the primary decision (in which is taken into consideration how many descriptions out of the recognizable descriptions and with what degree of belonging they belong to the class) will make a decision on belonging to the corresponding class with the degree of belonging. Exactly based on the results of the recognition of these control descriptions the recognition model will make a decision on the occurrence or non-occurrence of a disaster in the zero block. This is conditioned by the fact that after making a transformation of these learning descriptions on the basis of them are determined such knowledge and data bases which contains new functions – artificial parameters. These functions (as it has already been mentioned) indicate the internal hidden connections that exist between the values of the parameters given in the descriptions included in each class in relation to variants. It means that learning descriptions contain those maxmifs, mifs, and other characteristic features that correspond to the occurrence or non-occurrence of a disaster in the learning zero block. Besides, they are determined in relation to each month from the previous 12 months of the learning zero block, in the case of occurrence and non-occurrence separately, i.e. for each class separately. If recognizable descriptions are correctly recognized based on the same knowledge and data bases, they should also contain such maxmifs, mifs, and other characteristic features that correspond to the occurrence or non-occurrence of a disaster in the zero block (i.e. in the period in which the fact of occurrence or non-occurrence of a disaster is not known for them in advance and at the same time did not participate in determining knowledge and data bases). Therefore, in the case of correctly recognizing

control descriptions, their recognition indicates the fact that the same connections (artificial parameters, their meanings) correspond to the conditions of the previous 12 months of the learning zero block in the learning process. This correspondence also indicates the correspondence of occurrence or non-occurrence of a disaster in the zero block and the learning zero block in which it is known in advance.

Thus, at first, will be studied the condition of the previous 12 months of the zero block; the hidden connections between the parameters characterizing the disaster in relation to the months in case of occurrence and non-occurrence of a disaster will be determined. Then in the following year, in the same region and the zero block, this situation will affect the fact of occurrence or non-occurrence of a disaster. This will be confirmed also by the fact that since data bases are determined in relation to variants and classes, it is clear after the transformation on the basis of data bases of which class the control descriptions will be recognized, consequently, occurrence or non-occurrence of a disaster will be recognized in the zero block. The corresponding degree of belonging will be calculated based on the results obtained using the primary decisions [1].

Factually, the results of recognizing learning recognizable descriptions (which is determined using the slipping control procedure) and control descriptions show the results of recognizing new recognizable descriptions in the same region and period T_0. This is conditioned by the fact that the first model at the very beginning separates the control and learning recognizable descriptions from the primary learning descriptions. Because of this, it is implied that the fact of occurrence or non-occurrence of a disaster in the learning zero block is not known to them.

Therefore, it is obvious that control and learning recognizable descriptions will not participate in the formation of the corresponding knowledge and data bases in relation to the variants. It means that the learning zero block has the role of the zero block, as well as the control and learning recognizable descriptions – the role of new unknown descriptions which are determined in relation to the previous 12 months of the zero block. Moreover, they are recognized with the help of the knowledge and data bases determined in the learning process (in which control and learning recognizable descriptions do not participate).

Learning recognizable descriptions should be recognized in the learning process using knowledge and data bases determined in the previous years. Control descriptions, as well as new recognizable descriptions corresponding to the zero block, are recognized when the system completes its work. It is on the basis of the results of recognizing control descriptions that the occurrence or non-occurrence of a disaster in the zero block will be recognized. This is conditioned by the results of this recognition because they show how correctly these knowledge and data bases are determined on the basis of the learning descriptions in the learning process corresponding to the fact of the occurrence or non-occurrence of a disaster, how well the situation given in the previous period of the zero block is prepared for the occurrence or non-occurrence of a disaster in the same region and period, also to what extent it is possible to recognize the same disaster in the same region and period in the following year based on the knowledge and data bases determined in the learning process.

As for learning recognizable descriptions, their separation from the initial learning descriptions as well as their recognition helps the learning model to form appropriate knowledge and data bases corresponding to the number of variants and to correct data bases. They also help the recognition model in making primary decisions according to the number of variants and determining the detector of trust of the system. The results obtained after recognition of learning recognizable and control descriptions are reflected on the effectiveness of working of the SPRL and detector its trust elaborated by the recognition model.

The approach proposed above implies that for each month, the learning process will be conducted on the basis of their previous 12 months and the learning descriptions, as well as knowledge and data bases, will be separately determined for them. The results of recognition of learning recognizable, control, and also, new recognizable descriptions participate in the process of specification (correction) of these data bases. As the recognition model takes into consideration the correction of data bases based on the results of the recognition of the above-mentioned recognizable descriptions, the first two of them will be corrected if these descriptions belong to the class with any degree of belonging. The third of them will be corrected when the new recognizable descriptions belong to the corresponding class with the degree of belonging that equals only to one. This indicates that the more frequently the system works, the more reliable will be the subsequent recognition results

in case of occurrence and non-occurrence of a natural disaster. It will be more convincing to evaluate (recognize) the possibility of occurrence of a disaster.

Unlike object recognition, in the case of forecasting (recognition) disaster in the given region and period, taking into consideration its complexity and specificity, it is necessary to have the data of at least 5-5 years for each class separately, i.e. in case of occurrence and non-occurrence of a disaster. Based on them, we will determine the knowledge and data bases. From the knowledge and data bases, only those will be used separately for forecasting natural disasters in the following years, on the basis of which the correct decision was made about the occurrence or non-occurrence of natural disasters. In case the decisions made on the basis of different knowledge and data bases coincide, the degrees of belonging of these descriptions will increase according to the following:

$$d = d_1 + d_2 - d_1 d_2 , \quad (1)$$

where d_i, $i = 1,2$ $i-$ is the degree of belonging of a description to a class. The effectiveness of the working of the system and its detector of trust will increase accordingly (their determination on the basis of the degree of belonging to a class, also based on the results of recognition of learning recognizable and control descriptions is considered in the recognition model). In order to choose knowledge and data bases to forecast natural disasters in the following years, we consider the effectiveness of working of the system and its detector of trust as the characteristics of the knowledge and data bases. Let us mark them with E and T accordingly. After this, we will use the vector-optimization method according to which those bases that belong to the Pareto set will be considered as the best knowledge and data bases.

The vector optimization method of choice is used even if we have several knowledge and data bases and if it is based on one part from them; decisions are made on the occurrence of a natural disaster but are based on another part – on non-occurrence of a natural disaster in the same region and the zero block (what will not happen if the initial parameters are correctly chosen from the beginning). In the case of the above-mentioned, knowledge and data bases will be divided into two groups. The vector optimization method of choice is used for each group separately. The detector of trust and the effectiveness of working the system will increase for each group separately according to the formula (1). If we consider them as vector components in relation to which group they were determined, we determine the lengths of these vectors. Depending on which group the vector length will be more (the system effectiveness of working will be closer to 1 and detector of trust – to T> 0.8), the knowledge and data bases will be used the next year to forecast occurrence or non-occurrence of the same natural disaster in the same region and period, i.e. the zero block (these numbers are taken presumably. They should be determined based on statistics when real data will be used).

After determining the knowledge base and data bases if they are determined on the basis of the real data, the recognition model also should recognize the descriptions determined based on the real data of the previous period of the same zero block and region in other years. Then, on the basis of the recognition results, the recognition model will forecast the natural disaster, as it happened in the case of control descriptions (for which the fact of occurrence or non-occurrence of disasters was also not known). After using the real data it can be necessary to change or add the initial parameters considered in the method of determining the initial learning descriptions [6].

Conclusions. To forecast natural disasters (floods, mudslides) in the given year t_o region, and the period T_0 with the system of pattern recognition with learning (SPRL), this objective should be set in the terms of pattern recognition with learning. After this, all three models included in the SPRL are used. The first model: determines descriptions in the given year t_o, region, and on the basis of the data of the previous 12 months of the period T_0; on the basis of the data given in other years also in the same region and period determines learning descriptions. From them, first of all, are separated the control descriptions, then the variants of learning and learning recognizable descriptions. After increasing the informativity of learning descriptions in the variants, using the combinatorial schemes, the second model determines; artificial parameters that show hidden connections between parameter values given in the learning descriptions; on the basis of learning descriptions in relation to variants and classes for each recognizable description determined one knowledge base but for each control description – knowledge base of the number of variants. On the basis of knowledge bases in this case

the same number of the data base is determined in relation to variants and classes, but in the first case – one data base. Consequently, based on the knowledge and data bases, the third model for learning recognizable descriptions, with the help of corresponding criteria, will make one decision of belonging to the corresponding class, for control description – primary decisions according to the number of variants and on their basis – one decision. Based on the corresponding arguments and according to the results of the recognition of control descriptions, the third model will forecast a natural disaster in the given region and period. After correcting the data bases, on the basis of the results of the recognition of control and learning recognizable descriptions, this model determines the effectiveness of working of the system and its detector of trust on which these recognition results will be reflected. The learning process should be based on at least 5-year data. They are presented separately and knowledge and data bases are determined according to them. Such bases are chosen from them on the basis of which in the learning process the control descriptions are assigned to the corresponding class with the maximum degree of belonging. When using real data, it may become necessary to change the initial parameters, which is considered in the method of determining the initial learning descriptions [6].

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ESTIMATING THE PROBABILITY OF THE EMERGENCY OPERATION OF THE QUARRY ELECTRIC LOCOMOTIVE TRACTION ELECTRIC DRIVE

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7448

ARTICLE INFO

Received: 24 December 2020
Accepted: 15 February 2021
Published: 28 February 2021

KEYWORDS

quarry electric locomotive, distribution law, traction electric drive, parameters irregularity, distribution density.

ABSTRACT

The paper deals with the problem of the assessment of the functionality of the multi-motor direct current traction electric drive of the quarry electric locomotive. The problem of the failure of electric drive motors because of extremely unsatisfactory state of the rail tracks and the wear of wheel pairs is analyzed. Taking into account the number of the existing repaired electric motors the probability of fitting up the traction electric drive with the electric motors with the widest electrical parameters variety is determined.

Citation: Artem Artemenko, Oleksii Chornyi, Valeriy Sydorenko, Serhii Serhiienko, Yurii Zachepa, Vitaliy Kuznetsov, Alisa Kuznetsova. (2021) Estimating the Probability of the Emergency Operation of the Quarry Electric Locomotive Traction Electric Drive. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7448

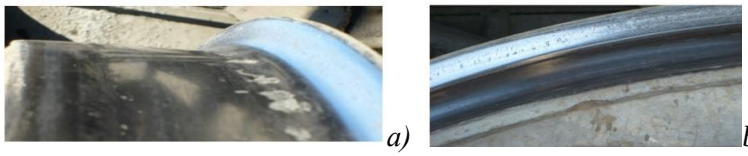
Introduction. The problem of improving the efficiency of quarry electric locomotives operation is being solved during several decades [1, 2, 3], but it has not been solved yet. Modern achievements and the latest developments of scientists in the field of the control of electromechanical systems (EMS), in particular, the electric drives of industrial electric locomotives [4, 5, 6], do not enable getting the required results as the condition of the rail tracks, mechanical equipment and traction electric motors is extremely unsatisfactory. It should be taken into account that the mentioned factors are directly interconnected and it is impossible to solve the problem of the high-quality repair of electric motors without the improvement of the condition of the tracks and wheel pairs. Fig. 1 contains fragments of rail tracks of quarry electric locomotives providing the transportation of the mining muck.

Such defects reflect on the state of the surface of the wheel pairs (Fig. 2). In some cases the wheel diameter decreases by 10-12 mm (Fig. 2, a), and new dents cause the appearance of the analogous damage of the rail surface (Fig. 2, b), and even variation of the geometry of the rail head.

Appearance of hollows, caverns, dents results in slippage, which additionally damages the rail track and the wheels at the point of their contact. When the diameter of a wheel decreases, the wheels in the wheel pair rotate at different speed, which results in continuous slippage of the wheel surface against the rail surface [7]. During the slippage the load is distributed irregularly between the traction motors. Motors with a higher load overheat and quickly fail also due to the presence of low-quality electricity in the contact network [8-14]. Motors are repaired at specialized repair enterprises allowing the following deviation of the output parameters according to the GOST state standard: the armature winding – 10% and the excitation winding – 2% [11-18]. The irregularity of the parameters results in irregular rigidity of mechanical characteristics and in irregular distribution of the load among the motors. That is why the research of the operation modes of quarry electric locomotives is a topical problem.

a) b) c)

Fig. 1. Fragments of the rail track condition: a) – break, b) – hollow, c) – dent



a) b)

Fig. 2. Fragments of the wheel pairs condition: a) – change of the wheel diameter, b) – dent

Problem Statement. Electric locomotive OPE-1A (OPE-1AM) is the main type of the quarry electric locomotive at Poltava Ore-Dressing and Processing Enterprise. It is designed for the operation on the strip mining railways electrified by alternating current with the voltage of 10000 V, the frequency of 50 Hz, ruling gradient of 60‰. The servicing part of the traction unit consists of six two-axle bogies, two in each section. The bogies are equipped with two wheel-motor blocks consisting of a wheel pair and a traction motor. Direct current series excitation motors DT9N (NB-511 for OPE-1AM) are used as traction motors; in continuous duty their rated power is 418 kW at the rated voltage and current respectively 1500 V and 300 A, maximal rotation frequency 160 s-1.

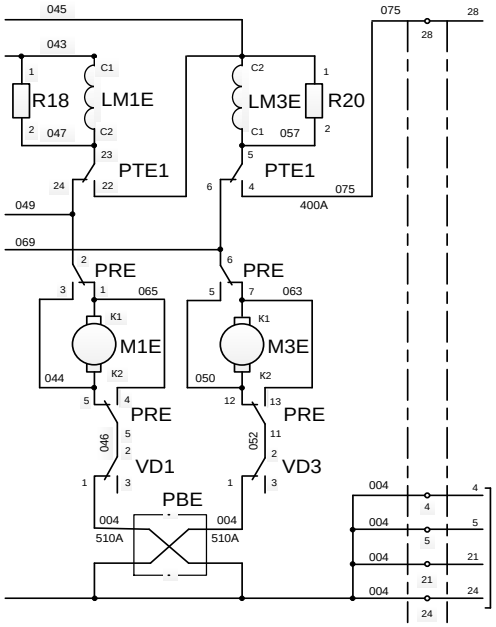


Fig. 3. A fragment of the basic power circuits of the electric locomotive TED: M1E, M3E – traction motors; PRE – reverser; PTE1 – brake switch; PBE – Locomotive wheelslip relay; C1-C2 – motors field winding; R18, R20 – shunt resistors of the motor field winding; VD1, VD3 – disconnectors of the motor; K1-K2 – motor armature; LM1E, LM3E – inductance of the motor field winding.

An electric locomotive is manufactured in a three-section variant and consists of a driving electric locomotive, a diesel section, a motor dump car. Sometimes a second motor dump car is installed instead of a diesel section. An electric locomotive is equipped with 12 traction motors. In the traction, autonomous and brake modes traction motors are connected in parallel in each traction unit (Fig. 3).

Admissible 10% deviation of the armature winding parameters in repaired traction motors is determined according to heat condition [7, 8, 9, 10, 13-15] and, if forced ventilation of the motors is available, allows long-term operation. However, it should be taken into consideration that an electric locomotive is equipped with 12 traction motors that are not especially selected for the operation in a multi-motor electric drive system as they are motors of the same type. In this case there is a possibility of such a situation when one electric locomotive unit will contain motors with parameter deviation within the tolerance but of opposite values. Let us consider a probability of such a situation.

Let there be N motors in the repair fund; they are characterized by a vector of a certain parameter deviation from the norm $\Delta=[\Delta_1\ \Delta_2 \ldots \Delta_i \ldots \Delta_N]^T$. Value Δ_i, that characterizes i-th motor may be both positive and negative and may repeat m times($1 \le m \le N$).

Results of the Research. We introduce an upper-triangle matrix of the modules of the first final pairwise differences ∇ characterizing the difference between the motors in the pair according to the preset parameter:

$$\nabla = \begin{pmatrix} 0 & \nabla_{12} & \nabla_{13} & \cdots & \nabla_{1j} & \cdots & \nabla_{1N} \\ 0 & 0 & \nabla_{23} & \cdots & \nabla_{2j} & \cdots & \nabla_{2N} \\ 0 & 0 & 0 & \vdots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & 0 & \nabla_{ij} & \cdots & \nabla_{iN} \\ 0 & 0 & 0 & 0 & 0 & \vdots & \vdots \\ 0 & 0 & 0 & 0 & 0 & 0 & \nabla_{(N-1)N} \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 \end{pmatrix} \quad (1)$$

With the dimension of $N \times N$ (the number of the elements $(N^2-N)/2$), its elements are calculated by the following rule:

$$\nabla_{ij} = \begin{cases} \left|\Delta_{ij}\right| = \left|\Delta_i - \Delta_j\right|, & \forall i < j \\ 0, & \forall i \ge j \end{cases}. \quad (2)$$

If $\nabla_{ij} \approx 0$ or $\nabla_{ij} = 0$, it means that the difference between the i-th and the j-th motor by preset parameter Δ, is respectively minimal or absent.

We are interested in the maximal value $\max(\nabla_{ij}) = \nabla_{\max}$. Naturally, $\nabla_{\max}$ may repeat k_{max} times (in theory $1 \le k_{max} \le N-1$).

Let us estimate the probability of the situation when during the selection of 12 motors for a locomotive there will be a pair corresponding to $\nabla_{\max}$: a) once; b) at least once.

On the basis of the hypergeometric distribution of probabilities it is possible to write down a probability that during the selection of 12 motors out of N the number of the chosen ones will include exactly k ($1 \le k \le k_{max}$), corresponding to $\nabla_{\max}$:

$$p(\nabla_{\max}, k) = \frac{C_{k_{\max}}^{k} \cdot C_{N-k_{\max}}^{12-k}}{C_N^{12}}. \quad (3)$$

Then for the probability of the extraction of one such pair it is possible to write down (one pair – k=2):

$$p(\nabla_{\max}, 2) = \frac{C_{k_{\max}}^{2} \cdot C_{N-k_{\max}}^{10}}{C_N^{12}}.$$

In practice N=100...400. Let us consider the "worst" case when the repair park is minimal, i.e., N=100 and, e.g. there is a chance to select k_{max}=12 (6 pairs) of motors with the maximal difference by the parameter. Then

$$p(\nabla_{\max}, 2) = \frac{C_{12}^{2} \cdot C_{88}^{10}}{C_{100}^{12}}.$$

Taking into account that $C_n^k = n!/(k!(n-k)!)$ and n is big, Stirling's formula will be used for the calculation of factorials:

$$n! \approx \sqrt{2\pi n}\left(\frac{n}{e}\right)^n.$$

Then $$p(\nabla_{\max},2)=\frac{C_{12}^{2}\cdot C_{88}^{10}}{C_{100}^{12}}=0.284,\ \text{i.e. } 28.4\%. \qquad \text{.....(4)}$$

The probability of the situation when during the selection of 12 motors at least one pair will be with the maximal difference of the conditions is:

$$p(\nabla_{\max},(k=2)\vee(k=4)\vee(k=6)\vee(k=8)\vee(k=10)\vee(k=12))=\sum_{m=2,4...12}\frac{C_{12}^{m}\cdot C_{88}^{12-m}}{C_{100}^{12}}=0.314, \qquad (5)$$

i.e. 31.4%.

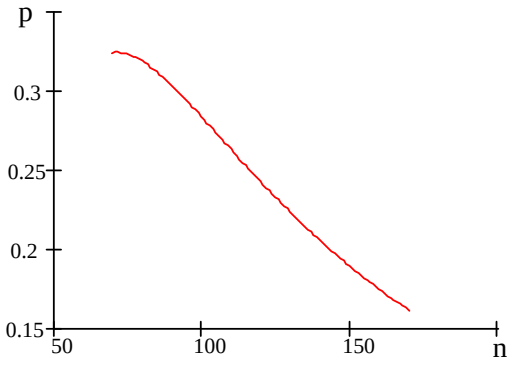


Fig. 4. The probability of the situation when during the selection of 12 motors out of n motors of the repair park one pair will be with the maximal difference of the parameters

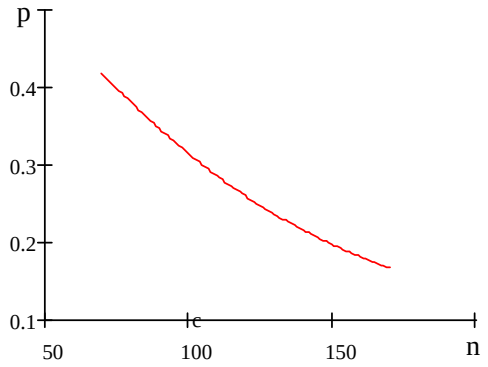


Fig. 5. The probability of the situation when during the selection of 12 motors out of n motors of the repair park at least one pair will be with the maximal difference of the parameters

The obtained results reveal that in every third case there may be a situation that will be unfavorable from the point of view of the reliability characteristics of the wheel pair of the electric locomotive after repair.

As mentioned above, to get real assessment of the said probabilities it is necessary to know the law of distribution of value Δ_i of the preset parameters as it would allow the assessment of the share of the motor pairs with maximal deviations from the preset parameter.

Let Δ^k be a casual deviation of the *k*-th parameter of the electric motor after repair. For the convenience of further reasoning let us pass to relative deviations

$$\delta^k=\frac{\Delta^k}{r_{nom}^k}\cdot 100\%, \qquad (6)$$

where r_{nom}^k – rated (published) value of the required parameter. As transform (6) is of linear character, the form of the law of distribution of probabilities of Δ^k and δ^k coincide. Let the law of distribution δ^k be preset by the density of probability $f_{\delta^k}(x,\Theta^k)$, i.e. $\delta^k \sim f_{\delta^k}(x,\Theta^k)$, where $\Theta^k=\left(\Theta_1^k,\Theta_2^k,...,\Theta_1^S\right)^T$ – vector of the distribution parameters. It is necessary to:

1) assess $f_{\delta^k}(x,\Theta^k)$;

2) assess the probability of the situation when two motors of size *N*, randomly chosen out of the repair fund, will have critical deviations by the *k* - th parameter;

3) assess the probability of the situation when two motors of size *N*, randomly chosen out of the repair fund, will have critical deviations by at least one of *k* ($k=\overline{1,K}$)parameters.

The assessment of the law of distribution $f_{\delta^k}(x,\Theta^k)$ requires structural and parametrical identification of the model. Taking into account the complexity of obtaining the sufficient amount of empiric data, which would provide the opportunity to suggest and verify a definite statistical hypothesis as to the model, we will consider the assessment of the law of distribution based on a number of a priori assertions and suppositions.

By virtue of the central limit theorem we can suppose, that the law of distribution δ^k should have a normal or at least an asymptotically normal law of distribution with zero mathematical expectation (μ=0):

$$f_{\delta^k}(x,\mu,\sigma)=\frac{1}{\sqrt{2\pi}}e^{\frac{-(x-\mu)^2}{2\sigma^2}}. \quad (7)$$

However, according to the standard requirements, the absolute value of the post-repair deviation of the preset parameter *k* cannot exceed a certain admissible value. Otherwise the electric motor is considered unfit for operation and does not replenish the repair fund. In other words, in practice, it is necessary to have not a normal but a truncate normal law of distribution with symmetrical boundaries and it should be preset by the following expression with four parameters:

$$f_{\delta^k}(x,\mu,\sigma,x_1,x_2)=\begin{cases}0 & x\le x_1\\ \dfrac{\phi\left(\dfrac{x-a}{\sigma}\right)}{\sigma\left(\Phi\left(\dfrac{x_2-a}{\sigma}\right)-\Phi\left(\dfrac{x_1-a}{\sigma}\right)\right)} & x_1<x\le x_2,\\ 0 & x>x_2\end{cases} \quad (8)$$

Where $\phi(x)\frac{1}{\sqrt{2\pi}}e^{-\frac{t^2}{2}}$ – Laplace's function, $\Phi(x)=\frac{1}{\sqrt{2\pi}}\int_0^x e^{-\frac{t^2}{2}}dx$ – Laplace's integral function. In this case three out of four components of the distribution parameter vectors can be considered exactly preset:

$$\Theta^k=\begin{bmatrix}\mu\\ \sigma\\ x_1\\ x_2\end{bmatrix}=\begin{bmatrix}0\\ \sigma_k\\ x_{1k}\\ x_{2k}\end{bmatrix},$$

where x_{1k}, x_{2k} – particular tolerances for the *k*-th parameter, $\sigma_k=\frac{1}{(n-1)}\sum_{i=1}^{n}(\delta_i^k-mean(\delta_i^k))^2$ – sample point unbiased and consistent assessment of parameter σ, $mean(\delta_i^k)=\frac{1}{n}\sum_{i=1}^{n}\delta_i^k$, n, n – sample size.

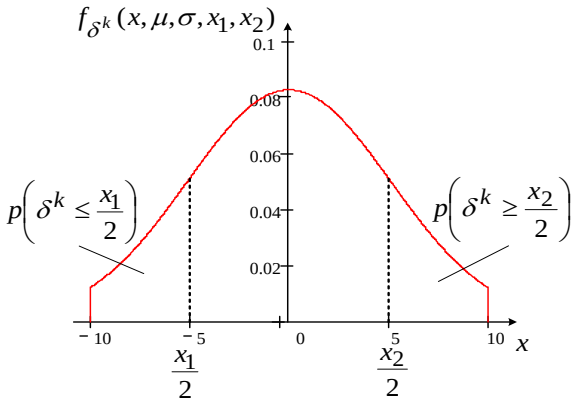


Fig. 6. A view of the density of the distribution of the truncate normal distribution with a parameter vector

$$\Theta^1=\begin{bmatrix}\mu\\ \hat{\sigma}_1\\ x_{11}\\ x_{21}\end{bmatrix}=\begin{bmatrix}0\\ 5.077\\ -10\\ 10\end{bmatrix}.$$

Then the probability of getting into the left-hand and the right-hand critical zone are equal and are determined as

$$p\left(\delta^k\ge\frac{\max}{2}\right)=p\left(\delta^k\le\frac{\min}{2}\right)=p\left(\delta^k\ge\frac{x_2}{2}\right)=\int_{\frac{x_2}{2}}^{x_2}f_{\delta^k}(x,\mu,\sigma,x_1,x_2)dx. \quad (9)$$

Consequently, the probability of the situation when during the selection of two motors for one wheel pair one will choose two specimens with deviations by the preset parameter *k* that will be

diametrically opposite and of the type that $|\delta_1-\delta_2|\geq x_1$, will be equal to the following, according to the theorem of multiplication of dependent events

$$p\left(\left|\delta_1^k-\delta_2^k\right|\geq x_1\right)=p\left(\left(\delta^k\leq\frac{x_1}{2}\right)\cap\left(\delta^k\geq\frac{x_2}{2}\right)\right)=2\cdot p\left(\delta^k\leq\frac{x_1}{2}\right)p\left(\frac{\delta^k\geq\frac{x_2}{2}}{\delta^k\leq\frac{x_1}{2}}\right). \quad (10)$$

Finally, the probability of the situation when two motors of size *N*, randomly selected out of the repair fund, will have critical deviation by at least one of *k* parameters can be calculated by formula:

$$p\left(\left(\left|\delta_1^1-\delta_2^1\right|\geq x_{11}\right)\cup\left(\left|\delta_1^2-\delta_2^2\right|\geq x_{12}\right)\cup\ldots\cup\left(\left|\delta_1^K-\delta_2^K\right|\geq x_{1K}\right)\right)=1-\prod_{k=1}^{K}p\left(\left|\delta_1^k-\delta_2^k\right|<x_{1k}\right). \quad (11)$$

As an example, let us consider a case with two parameters: armature winding resistance ($R_я$) and excitation winding resistance ($R_в$). The distribution parameter vector for the armature

$$\Theta^1=\begin{bmatrix}\mu\\ \hat{\sigma}_1\\ x_{11}\\ x_{21}\end{bmatrix}=\begin{bmatrix}0\\ 5.077\\ -10\\ 10\end{bmatrix}.$$

For the excitation winding – $\Theta^2=\begin{bmatrix}\mu\\ \hat{\sigma}_2\\ x_{12}\\ x_{22}\end{bmatrix}=\begin{bmatrix}0\\ 1{,}106\\ -2\\ 2\end{bmatrix}$.

The assessment of parameter σ is obtained on the basis of the selective data

Then, according to formula (6), the following is true for the armature:

$$p\left(\delta^1\geq\frac{\max}{2}\right)=p\left(\delta^k\leq\frac{\min}{2}\right)=p\left(\delta^k\geq 5\right)=\int_5^{10}f_{\delta^1}(x,0,5.077,-10,10)dx=0.145.$$

It means that ≈15 motors at N=100 have the value of resistance exceeding half of the admissible one on the right, i.e. 5%, and the same number of motors with deviation on the left.

Analogously, for the excitation winding:

$$p\left(\delta^2\geq\frac{\max}{2}\right)=p\left(\delta^2\leq\frac{\min}{2}\right)=p\left(\delta^2\geq 1\right)=\int_1^{2}f_{\delta^2}(x,0,1.106,-2,2)dx=0.15889.$$

Then the probability of the situation when during the selection of two motors for one wheel pair one will choose two specimens in which the deviations of the armature winding will be diametrically opposite and of such type that $|\delta_1-\delta_2|\geq 10$ by formula (10) will equal:

$$p\left(\left|\delta_1^1-\delta_2^1\right|\geq 10\right)=p\left(\left(\delta^k\leq -5\right)\cap\left(\delta^k\geq 5\right)\right)=2\cdot p\left(\delta^k\leq -5\right)p\left(\frac{\delta^k\geq 5}{\delta^k\leq -5}\right)=\frac{15}{100}\cdot\frac{15}{99}\cdot 2=0.04545.$$

Analogously, for the excitation winding:

$$p\left(\left|\delta_1^2-\delta_2^2\right|\geq 1\right)=p\left(\left(\delta^1\leq -1\right)\cap\left((\delta^1\geq 1)\right)=2\cdot p\left(\delta^2\leq -1\right)p\left(\frac{\delta^2\geq 1}{\delta^1\leq -1}\right)=\frac{16}{100}\cdot\frac{16}{99}\cdot 2=0.05172.$$

Finally, the probability of the situation when two motors of size *N*, randomly selected out of the repair fund, will have critical deviation by at least one of the parameters analyzed by formula (11) will be:

$$p\left(\left(\left|\delta_1^1-\delta_2^1\right|\geq x_{11}\right)\cup\left(\left|\delta_1^2-\delta_2^2\right|\geq x_{12}\right)\right)=1-\prod_{k=1}^{2}p\left(\left|\delta_1^k-\delta_2^k\right|<x_{1k}\right)=1-p\left(\left|\delta_1^1-\delta_2^1\right|<x_{11}\right)p\left(\left|\delta_1^1-\delta_2^1\right|<x_{11}\right)=$$

$$=1-(1-0.04545)(1-0.05172)=0.095\approx 0.10,$$

i.e. in every tenth case during the repair the selected pair may be of such a type that, at least by one parameter, there will be a deviation exceeding the admissible norms.

Conclusions. The performed analysis of the condition of the mechanical, electromechanical equipment of the quarry electric locomotives and rail tracks reveals that, due to the deviation of the parameters of traction motors after repair in the electric locomotive multi-motor electric drive there occurs irregular distribution of load among the motors, the overheat of more loaded motors and their failure. Irregular distribution of load causes slippage resulting in the damage of the rail tracks and the

wheels of the electric locomotive. The calculated probability of fitting up the electric drive with motors with the widest variation of parameters reaches 30% in the existing repair park of traction motors. An analysis of mechanical characteristics of the two-motor electric drive has been carried out. It takes into account the slippage caused by the condition of the rail track. The growth of losses of the overloaded motor results in the decrease of its insulation durability by 25%. Taking into consideration the fact that there is no possibility of control of a separate track motor on the electric locomotive, high accident rate will remain in the future. The equalization of the irregular load among the motors caused by the irregular parameters and the deterioration of the coefficient of traction is only possible by means of additional control of the motor magnetic flux. Besides, the synthesis of a SMART-system of control of traction electric drive with the functions of self-control and analysis will provide the improvement of the efficiency of the operation of traction electric drives of quarry electric locomotives. It is also possible to solve the above problem by using additional power sources for electric motors, as alternative sources.

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ARCHITECTURE AND CONSTRUCTION

REVITALIZATION OF THE URBAN WATERFRONT AREAS

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DOI: https://doi.org/10.31435/rsglobal_ws/28022021/7449

ARTICLE INFO

Received: 16 December 2020
Accepted: 12 February 2021
Published: 28 February 2021

KEYWORDS

structural-planning reorganization, waterfront areas, water diameter, recreational framework, revitalization, rehabilitation of riparian territories.

ABSTRACT

The article presents a strategy for renovation in the riverside area: improvement of water protection functions; rehabilitation of disturbed territories; the use of recreational and urban planning potential of such territories for creating a recreational framework on the waterfront; integration of eco-clusters into the structure of riverside territories and the development of an integrated management system for waterfront zones. As a result of the research, the necessity of rethink the attitude to urban planning within the riverside areas is formulated. Possibilities of sustainable development of riparian territories are determined. Stages of rehabilitation of communal warehousing and industrial territories for sustainable development and rehabilitation of urban areas are proposed. A formalized model of structural renovation of the exploring areas are being built, on the basis of which the identified principles of rehabilitation are being tested. The significance of the obtained results for urban science lies in the development of new approaches to the identification and formation of the structure of territories in the area of interaction with the water area. In the formulation of the basic principles underlying the structural and planning transformations of riparian areas.

Citation: Yevheniia Samoilenko. (2021) Revitalization of the Urban Waterfront Areas. *World Science.* 2(63). doi: 10.31435/rsglobal_ws/28022021/7449

Introduction. Features of recreational use of urban areas, in particular the formation of landscape structure and integrated landscaping system of the coastal area in relation to the water area, the creation of water-green diameters, revitalization of river valleys, the formation of individual water-green objects, clustering - notable modern urban trends many cities around the world are still not sufficiently implemented in the cities of Ukraine. World experience shows that a systematic approach to the urban organization of riparian areas includes complex environmental and recreational tasks: management of surface runoff within the catchment; protection of territories from flooding and flooding, which can be implemented in particular in a landscape way. These processes are confirmed by the relevant planning documents, but have not yet become widespread.

Solving the functional and planning needs of the city and the architectural and landscape organization of recreational spaces in its structure is complicated by the peculiarities of the river landscape and its interaction with the urban environment [4].

The issues of rehabilitation of the existing urban structure are becoming key in urban planning. The balance of urbanized and recreational elements is also important for the sustainable development of the city. Riverside areas, being part of urban areas with varying degrees of urbanization, have great urban, natural and recreational potential. Urban "smart-development" of riparian areas is associated with environmental safety, structural and functional transformations of the territories, with the identification of their condition and rehabilitation opportunities. In order to transform urban areas and their further sustainable development, to create a comfortable, accessible, aesthetically pleasing environment. In order to form a recreational framework in the structure of the river zone of the city.

The processes of rehabilitation of urban structures, and riparian areas in particular, are based on closely integrated market conditions, state planning and local interests of communities [1]. The key importance is attached to the stage development of the territories in accordance with the planned master plan of the city. At the same time, one of the main principles of sustainable development of the river zone is the creation of a single water-green, ecological-urban framework of the city. This principle provides for the analysis of the ecological state of functional zones in the structure of riparian areas, their restoration, removal of environmentally hazardous enterprises with subsequent rehabilitation of territories. The aim is also to create significant green areas within the coastlines that perform recreational and conservation functions. Rehabilitation of riparian urban spaces contributes to the improvement of the ecological condition and restoration of the urban environment. The composition of permissible functional zones in the structure of riparian areas, building density parameters, is considered as a tool and an opportunity to create a comfortable environment, achieved through close integration of landscape infrastructure, structural and planning reorganization of urban fabric on the border with the water area. Equally important are changes in the structure of urban mobility, the formation of a continuous pedestrian framework of the city, which aims to create a system of pedestrian mobility that integrates the linear and nodal components of the spatial planning infrastructure of the river zone of the city.

Materials and methods. Activation of water protection functions of river areas. Great importance in the greening of the city is given to the formation of its ecological infrastructure, an integral part of which is the system of greenery and the water area of the city, which comprehensively form a natural recreational framework. This is a system of natural type, which provides the creation of appropriate, from an ecological point of view, living conditions in the city, allows the continuity of the natural framework in the city and forms a connection with suburban recreational areas (Fig. 1).

Fig.1 Identity of recreational frame of the city

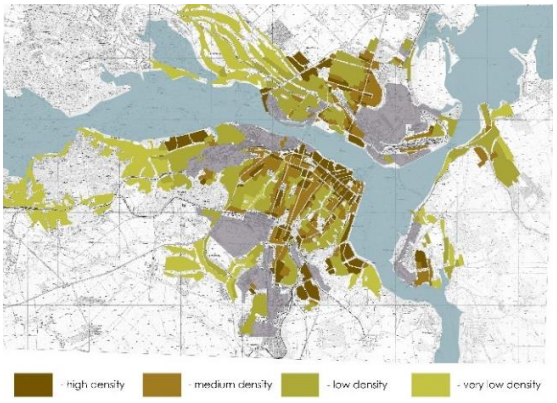

Fig.2. Industrial areas in the riverside territory

The methodology of spatial-functional formation of the urban environment in the water area takes into account the transformation of the coastal zone into a spatial-thematic scenario together with the need to integrate the entire number of local urban planning tasks. Analysis of possible vectors of river space development within the city with the formation of a contact zone in its structure, as a tool for project modeling, makes it possible to regulate the structural components of buildings and landscaping within the water area, creating a contact area with meaningful levels of interaction of river basins [3].

Rehabilitation of riparian areas, which means a set of measures within the riparian space, contributes to the territorial restoration and implementation of the principles of ecological sustainability, humanization and social orientation of the environment, maintaining the balance of natural and anthropogenic components of urban landscape and recreational needs of urban population. In this period of development, riparian areas are functionally rich and urbanized space. The study of the development of the territorial-spatial structure of cities in relation to the water systems allowed to determine that the riparian areas are prone to varying degrees of urbanization, some of them need renovation and replacement. One of the main goals of the reconstruction projects is to determine approaches to the transformation of the landscape system of the city of Dnipro into an efficient and stably functioning urban framework. However, many aspects concerning the forms of urban landscape transformation and natural forms in terms of their spatial characteristics and role in shaping the composition of the city, as well as the process of forming the ecological and urban framework and the organization of open spaces remain

unclear. Thus, the master plan, as a regulatory document, should determine the path of transformation of the urban environment in the direction of the vector of sustainable innovative development of the territory on the basis of the introduction of a new structural element of the natural complex.

Acquisition of qualitatively new content in the interaction of man and nature can be realized under the conditions of providing territorial-spatial and urban processes of culturological content. Thus, the issue of functional orientation on landscape reconstruction of territories along the waters of large rivers is actualized in a number of scientific works that were included in this study. According to them, the analysis of the existing functional use of the coastal zone of the city of Dnipro showed that residential buildings, as well as public and industrial zones occupy up to 80% of the area of all developed river areas. According to the sum of factors, the location of residential buildings near the central zone of the city gives a greater economic effect from the use of the territory than the formation of recreational complexes, but contradicts the need for green spaces. Industrial territories located in the middle zones of the city and in the structure of riverine territories (Fig. 2). They are polluted, decayed and even dangerous for the development of the territory. Numerous foreign studies have concluded that Brownfields, using the capabilities of existing infrastructure, have great potential for sustainable development. These areas are part of planning strategies to combat urban sprawl. These areas are used to achieve a balance in the strategies of spatial planning and regeneration of urban areas [2]. The article considers the possibility of creating a recreational cluster, which will ensure certain continuity of natural framework, regarding its multi-vector formation in the urban space. This connection of the recreational cluster with the suburban green belt and water area, will allow establishing a pedestrian and recreational framework inside and outside the city. In the context of the functional organization and location of industrial zones in the structure of the riparian areas of the great river, three different approaches to their extension have been identified.

- *Restoration of industrial facilities with a possible change in the function of the facility*. Bringing the object to the status of a memorial, a monument of industrial architecture. Analysis and development of strategy and stages of work depending on the complete, detailed restoration, the need for reproduction. Identification of working technology, the urgency of modernization, the need for improvement. The industrial function is preserved, however, the position of the functional zone in the waters of the water is contradictory. The size of the occupied territory, the percentage of operating and functioning enterprises requires a detailed analysis.

- *Partial functionalization of industrial territories.* Uncompetitive industry, further complete change of technology, and the need for functional transformation of the structure. Reconstruction and preservation of the main planning structures of the building. Conservation or museification of the object depending on further strategies. Inclusion of objects of a new type, characteristic of the era of refunctionalization, in the structure of a historic industrial facility.

- *Full functionalization of industrial areas.* Functionalization of the existing monument of industrial architecture, Relatively relevant socio-cultural criteria, and structural transformations of the functionalization of the territory, identification of stages of rehabilitation from industrial pollution. Assessment of the historical value of objects. Changing the industrial function in accordance with urban development strategies. Ecological rehabilitation of the territory. Strategy formed after a detailed analysis. Reclamation of the territories which have got to a pollution zone, increase in percent of a recreational component.

The research methodology included the use of the method of complex factor-by-factor analysis to identify the urban potential of the territory, using a systematic approach and study of graphic, cartographic, normative materials, with data on structural and planning and landscape organization of the urban environment. The study conducted a multifaceted, comprehensive assessment of the factors influencing the development and organization of the riparian areas of the Dnieper River within the city of Dnipro. A number of conflicts have been recorded. To a large extent, the cause of pollution of the surface waters of the Dnieper is the lack of adequate systemic actions and efforts to combat the consequences, rather than to eliminate the factors that cause the negative impact. Thus, the main reasons that led to the threatening state of the environment can be considered: outdated production technology and equipment; high energy and material consumption, which exceeds two or three times the corresponding indicators of countries; high level of concentration of industrial facilities; unfavorable structure of industrial production with a high concentration of environmentally hazardous industries.

Results. Programs for the conservation and restoration of river ecosystems should be aimed at minimizing damage to the sustainable functioning of the basin and preserving the integrity of river

systems. The purpose of this analysis was to obtain a systematic view of the formation of infrastructure within the water area in the process of urban planning and urban development. In order to improve the environmental situation in the Dnieper region, the main activities have been identified. The recreational framework of the city of Dnipro was revealed (Fig. 3). The comprehensive program should be formed in order to improve the ecological condition of the Dnieper basin, solve the problems of waste management, especially toxic and unsuitable ones, and improve the system of ecological monitoring in the region. Environmental protection, rational use of natural resources, ensuring the environmental safety of human life are essential conditions for economic and social development of the region. In areas of long-term development, the question arises about the relationship between the current urban situation and new forms, methods of rehabilitation that meet modern priorities of landscape originality, accessibility, spatial diversity, inclusion of riparian areas and water space in city life.

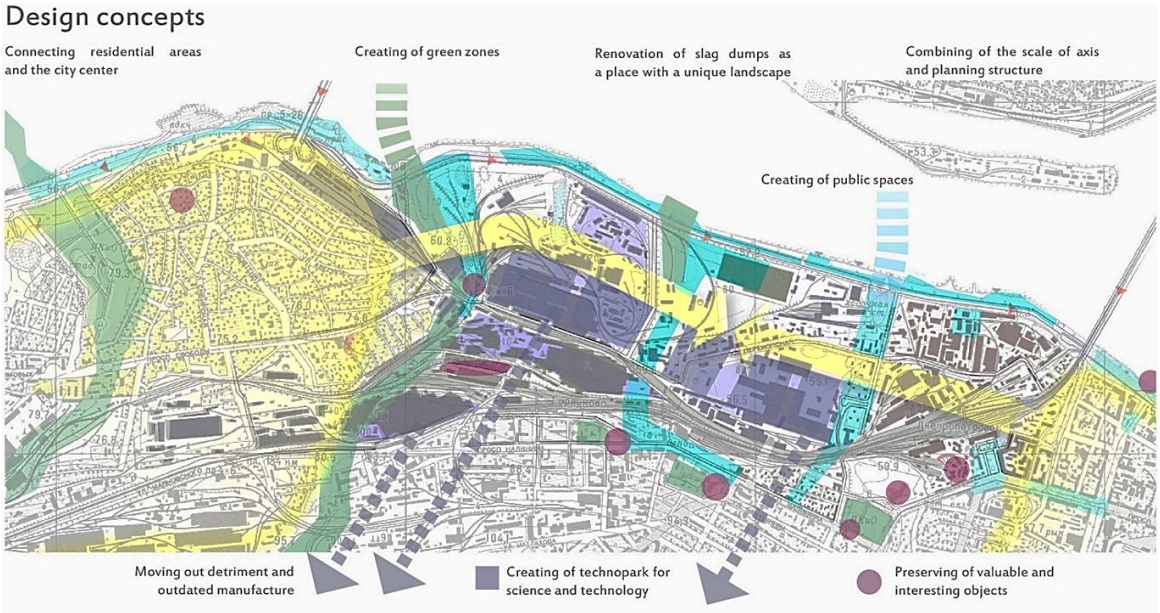

Fig. 3. Analysis of the riverside areas in the city structure. Coastal transformation strategies.

The main principles of renovation of industrial areas of the city on the example of the city of Dnipro. Conditionally riparian areas are divided by the type of their use of the territory. They include: areas of production and storage facilities, areas of individual housing, areas of multi-storey housing, recreation areas, green areas and sports areas. In the scheme of planned activities, they are presented in different colors, according to the symbols. The main measures of environmental, communication and social areas take into account the nature of land use, as well as involve the functional content of a particular area. As a result of the carried out work, taking into account the revealed problems within territorial limits of research, three basic directions of the organization of coastal space are offered: ecological, communication and social.

Ecological direction of landscape organization. The ecological direction of the territory development is the formation of a single structure of green spaces, which can be described as a recreational corridor, due to the preservation of existing green areas and the formation of new in the structure of areas to be renovated and alluvial areas. The main principles of this direction, which underlie the development of methodological approaches are: the principle of preservation, restoration and development of the natural potential of the territory; the principle of forming a barrier-free ecological environment; principle of parity; the principle of adaptation, humanization and social orientation.

Communication direction of landscape organization. The communication direction of the territory development is the formation of the main connections of the river area with the city in general, with the adjacent residential areas in particular, and provides the connection of the planned points of gravity along the river. The principle of communication direction and general accessibility implies the availability of different age groups and different degrees of mobility. The main principles of this area are: urban planning principles; the principle of general accessibility; the principle of connectivity of the territory and adaptation; the principle of inventory and significance, priority; the principle of the cultural matrix.

Social direction of landscape organization. The social direction of the territory development consists in the formation of contact zones and communicative recreational objects, within the water area of the city, which function evenly and are structural objects of the system of recreational pedestrian corridor along the water area. The main principles of this direction: the principle of forming a comfortable environment; the principle of multifunctionality; the principle of comprehensive renovation; the principle of compliance with socio-economic requirements; the principle of aesthetic harmonization of the environment; the principle of sustainable development and environmental safety.

Integration of eco-clusters into the structure of riparian areas. Changing the quality of the urban environment in the direction of the vector of sustainable development of the territory is possible on the basis of the formation of principles and methods of rehabilitation of riparian urban areas. Significantly increase the level of innovation activity will allow the use of cluster approach in the formation of recreational corridors along the water area, introducing technopark structures replacing industrial areas, creating tourist and recreational areas as poles of economic growth, forming communication spaces, sustainable recreational ecoclusters. One of the approaches to the restoration of industrial areas is their ecological rehabilitation: reclamation of areas covered by the pollution zone; transformations within the transport infrastructure: bicycle connections, development of high-speed rail transport, organization of communication complexes within the embankment.

Development of a system of integrated process control in the riparian zone. On the one hand, uncontrolled self-filling of urban areas with natural elements affects the overall balance of green areas in cities, on the other hand, provokes social and urban conflicts. This property of "uncontrolled landscaping" of urban areas allows urban policy to assess the reserves of environmentally friendly development. For example, the Open Space Strategy, launched in the United Kingdom, officially regulates the use of river water protection zones as corridors of an ecological urban framework. This strategy also considers the small but important "green islands" between buildings and along roads as "informal natural areas", which also play a role in shaping the system of open urban spaces [5].

Conclusions. As a result of the research in order to identify the techniques and principles of structural and spatial transformations of river areas, their current state is analyzed, with a comprehensive urban analysis and identification of their urban potential. The principles and methods of structural-density and morphological transformations that can be used in projects of sustainable development and rehabilitation of the formed urban river areas have been developed.

These principles have the opportunity to be implemented through a number of methods of urban organization. The main directions of the organization of the coastal space are aimed at forming a clear comprehensive strategy for the transformation of the structure of the recreational facility in accordance with current trends. Within the city, the river space is formed in a complex way, as a strategic object in the context of ecological planning programs, as the main element of the framework of water-green diameter, ecological corridor. All principles function in synergetic dependence, are complexly connected with each other, in this connection, a complex of measures on landscape organization, rehabilitation, renovation is applied in the developed territories.

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WORLD SCIENCE

DOI: https://doi.org/10.31435/rsglobal_ws

№ 2(63)
February 2021

MULTIDISCIPLINARY SCIENTIFIC EDITION

Indexed by:

Passed for printing 23.02.2021. Appearance 28.02.2021.
Typeface Times New Roman.
Circulation 300 copies.
RS Global Sp. z O.O., Warsaw, Poland, 2021
Numer KRS: 0000672864
REGON: 367026200
NIP: 5213776394
https://rsglobal.pl/