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Authors are responsible for the accuracy of cited publications, facts, figures, quotations, statistics, proper names and other information.

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NECESSITY AND POSSIBILITY OF UNIVERSAL FINANCIAL CONTROL

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Abstract. The transformation of financial control in modern conditions is possible in various directions. The article argues for the need to reach the level of universality as a full implementation of the control function of finance. This process becomes possible thanks to the digitalization of economic development and the use of the advantages of a distributed registry and blockchain technologies.

Keywords: financial control, finance, financial relations, control function of finance, shadow economy, distributed registry, blockchain.

Financial control is currently going through a difficult period of transformation. On the one hand, it is widely ramified in three main areas - state, municipal and non-state. The first is implemented by federal executive bodies, chief managers of budgetary resources and administrators of income and financial sources. [9] The second is carried out within the framework of municipal self-government, focused on the priorities of territorial development. The third is represented by the forms of business management through the tasks of efficient use of financial resources in compliance with all legal requirements. [5]

There is a wide variety of types of financial control. This is a classification according to the criteria of the subjects of implementation, in which the state, departmental, public, intra-economic, independent are distinguished. From the standpoint of time criteria, a distinction is made between preliminary, current and subsequent. According to the specifics of implementation, planned, unscheduled and operational are known. There are many more types that differ in the areas of activity, including budgetary,

tax, banking, customs, as well as the specifics of the organization - for the targeted use of resources, mandatory and proactive, checks of documentation and the content of activities, etc.

At the same time, the main content of financial control, which consists in analytical observation of the dynamics of the cost proportions of gross domestic product (GDP), cannot be realized according to the above organizational structures. Experts point to the absence of a strictly formed and unified financial control system that could effectively and purposefully integrate all existing structures and organizations. The consequence of this is the active growth of both the number of inspections carried out and the number of inspection bodies and representatives.[1]

Much will depend on the priority areas for the development of financial control, the need for a general transformation of which is widely discussed among scientists and specialists. However, there are significant differences in approaches to solving theoretical and practical problems, due to the peculiarities of interpretations of general and particular foundations and components of financial control.

So, on the one hand, the definition of financial control based on the creation of a set of specific measures and operations in terms of organizing and conducting inspections and analysis of all types of economic activities is well reasoned and accepted by the scientific community. Including, one way or another related to the implementation of state economic policy. [7]

At the same time, on the other hand, there are many different versions of the individual components of control and their interaction at various functional levels of reproduction. This especially applies to the integration of legal and economic relations in the real absence of uniform financial and legal definitions and at least framework legislation. [6]

The noted discrepancies require new solutions based on the priorities of modern socio-economic development. In this context, the relevance of real forms and efficiency of one of the main functions of finance as such is becoming more acute.

First of all, it should be noted that the control function of finance that interests us in this case is, in its main essence, universal. This characteristic is due to the fact that this function has many specific forms and organizational implementations for the audit and analysis of the movement of GDP at all stages of reproduction. Therefore, the effectiveness of the function should consist of effective interaction with all components of economic life. [10]

It follows from this that the further development of the content of the control function of finance rests on the breadth of coverage of national

reproduction, and real financial control is now limited to a selective nature, and even then only in the legal part of reproduction processes. And control in the shadow economy and shadow financial relations is becoming more and more important. Therefore, in our opinion, the modern task of financial control is to extend its substantive functions to the shadow component of national reproduction.

Determining the specific parameters of the shadow economy as a space for the spread of financial control is largely complicated by the multivariance of interpretations. Among them are shadow economic activity and shadow relations, "gray", "black" and "white" spheres of the economy, etc. [11]

In a number of cases, integral indicators are proposed for use on the main criteria for the creation and use of GDP, income and expenses of organizations and citizens, the dynamics of employment and unemployment, and the level of taxation. In a number of cases, it is recognized that with the help of effective analysis and proposals to limit the shadow economy, highly developed countries have managed to reduce it to a level of 14-15 percent relative to GDP parameters. [4] This is, as it were, the minimum level of the shadow economy at the moment. But in any case, it is several times higher than the expected rates of economic growth, which significantly reduces the functional significance of all strategic programs of socio-economic development being developed.

Since, within the framework of our article, we cannot delve into discussions about individual estimates of the shadow component, we will single out the most generally accepted estimates of its parameters.

So, for example, according to the results of extensive global studies of the International Monetary Fund, as of 2018, the average share of the shadow economy, determined for 158 countries for the period from 1991 to 2015, amounted to 31.9 percent. [12]

In relation to Russian reality, according to the latest data from Rosstat, the dynamics of indicators of the shadow economy is characterized by large leaps (see fig. 1).
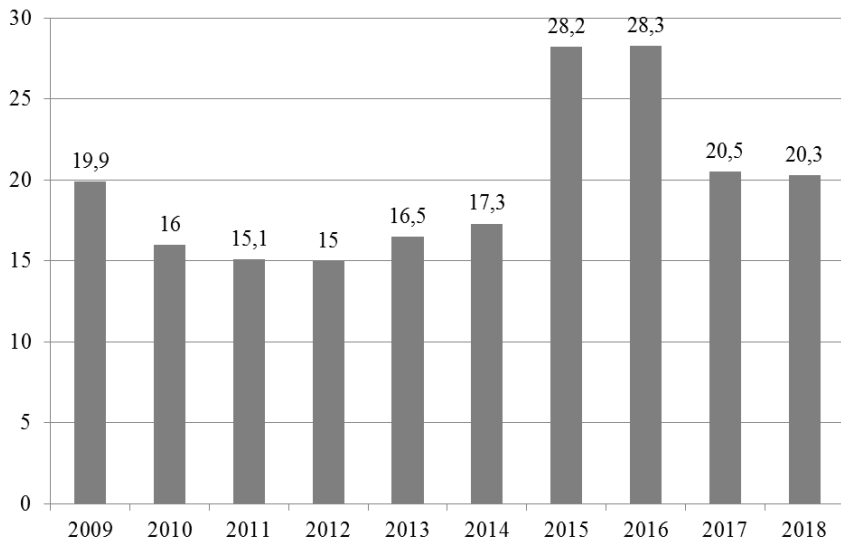
Figure 1. Indicators of the specific weight of the shadow economy (as a percentage of GDP) in the Russian Federation in 2009-2018 (calculated and compiled by the author based on the data of: N.V. Kapitonova, A.A.Kapitonova, Trends in the development of the shadow economy in modern Russia // Shadow Economy.– 2021.– Volume 5.– № 1.– P. 9-18)

Thus, we observe an almost twofold change in the level of the shadow economy in a relatively short period with repeated changes in the direction of the trend. But no matter how the presented trends are assessed, they in any case demonstrate that shadow relations extend to a significant part of the national economy.

Of course, the scientific literature raises the question of the development of many measures to overcome this phenomenon, or at least reduce its specific weight. [2]

In our opinion, effective financial control is becoming the main factor in reducing the level of the shadow economy. Here, there is a combination of two directions of modern economic development - the necessary formation of the universality of financial control, the possibility of which is created by the processes of digitalization of the national economy.

The priority technology appears to be an end-to-end distributed ledger system with integrated blockchain technology.

At the same time, the functional significance of the blockchain lies in the

ability to exclusively add data on new financial transactions if it is impossible to make changes to existing records that are stored in a distributed space and available to all participants. [3]

A new level of development of financial control is due to such advantages of distributed ledgers, such as universal and strict control over the actions of all participants in the financial market, provided, in turn, with all the completeness of information. [8]

Thus, digitalization is becoming a priority in the transformation of financial control, opening up the prospect of acquiring the character of universality, which can significantly improve the implementation of the control function of finance.

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PYRAMID SCHEMES AS A THREAT TO THE STABILITY OF THE RUSSIAN BANKING SYSTEM

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Abstract. The article is devoted to the question of the influence of pyramid schemes on the stability of the banking system of the Russian Federation. It is argued that pyramid schemes pose a threat to the country's financial security and destroy the foundation of the state's economy. The history of the emergence and activity of pyramid schemes shows that their appearance is almost always associated with serious difficulties in the country's economy. The main purpose of the work is to analyze the threats of the activities of pyramid schemes on the banking system of the Russian Federation.

Keywords: pyramid schemes, types of pyramid schemes, fraud.

The leading role in ensuring the normal state of the economy of any state is played by the credit and banking, business, investment and financial spheres. Under these circumstances, the question of ousting the shadow activity from the state economy, including that carried out with the use of pyramid schemes, acquires special significance [7].

One of the serious threats to the normal functioning of the economy of any state is the spread of pyramid schemes in the country. Currently, the Central Bank of the Russian Federation annually identifies hundreds of pyramid schemes in our country. As can be seen from table 1, in each next year there are dozens more such organizations than in the previous year.

The number of pyramid schemes detected by the Bank of Russia on the territory of the Russian Federation in 2017-2021 [5]

Years	Number of pyramid schemes
2017	137
2018	168
2019	237
2020	281
2021 (9 months)	279

It should be noted that pyramid schemes have a fairly long and rich history. According to the authors of the book "Ingenious Scams", back in the XVIII century, the first pyramid scheme was created by the famous Scotsman John Lowe. His attempt to improve the financial affairs of France by replacing gold and silver money with paper money was the first pyramid scheme, which ended with the collapse of both the pyramid he created and the French economy, as well as the career of John Lowe himself [3, p. 171-172; 1, p. 93-110].

A pyramid scheme is an organization whose profit is formed by the constant flow of new funds in the absence of any real activity or production of any product. In short, this is a fraudulent organization that offers to place investments at a "draconian" percentage of profit, while guaranteeing quick earnings for investors. The company does not produce or provide a product or service, but provides profit to early participants at the expense of late ones. Thus, there is a banal transfer of money from one hand to another [7].

The main goal of such a scheme is to enrich the organizers of the pyramid by investing money in it by new participants. Perhaps, those who entered the front ranks immediately and then withdrew their money in a timely manner will also remain in profit. The essence of the pyramid scheme is that the contributions of the participants are not invested anywhere and go to reward the upper levels, that is, those people who invited them to the number of participants and others superior to them along the entire chain of the pyramid. Accordingly, if the current investor also invites people, he will receive his income from them, etc. In some models, the presence of the production of some product to cover the "business" is possible, but the essence of this does not change: the profit in the pyramid is obtained only due to the investments of new participants.

The authors of the bestseller "100 modern scams" Alexander Vaksyan

and Yuri Svirin describe the activities of the most famous in the 1990s MMM pyramid by Sergey Mavrodi and reveal the essence of his pyramid as follows. "Followers of S. Mavrodi have created a network of secret societies of "mutual support" in the country. The recruitment of applicants is carried out without advertising through personal contact. The entrance fee - up to 3000 dollars. Then there is a refund from the newly accepted "partners". Each of them, in turn, must supply the society with three more. Already at the 10th step of the pyramid, this "support society" of 200 people should have 19.683 members, and at the 16th - 14.348.000 volunteers, which is absolutely unrealistic. If the creators of the pyramid manage to hide at the 10th stage, their net profit will amount to 44 million dollars. Partners of the 1-3rd stages will also have time to get something. The rest of the participants in "mutual support" with a 100% guarantee will lose the money invested"[2, p. 79].

The most widespread pyramid schemes in Russia were received during the transition of the Soviet economy to market rails. It was a period when enterprises were closed in our country, people were losing their jobs. It is this circumstance, in our opinion, that gave rise to the desire in them to earn money in the shortest possible time. Undoubtedly, aggressive television advertising played a huge role, portraying the possibility of a comfortable life for those who would invest, for example, in MMM. Nobody knows for certain how many Russians suffered from the "pyramids" in the 90s of the last century. In 1995, the losses of citizens and legal entities from fraudulent firms were estimated at 20 trillion rubles.

The Muscovites turned out to be the most gullible - the total account of their financial losses from various fraudulent companies in 1995 amounted to 7 trillion rubles, and of the 858 criminal cases on "pyramids" at the beginning of 1996, 329 were in the capital.

Russian legislation simply turned out to be not ready for such a difficult test, although since the end of the 80s, experts, mainly from law enforcement agencies, warned that the Russian credit and financial system is the least protected by the legislative framework from attempts on it by swindlers and swindlers [4, p. 263].

The distribution of funds of the new members is carried out according to different schemes. The principle of a pyramid scheme is as many newcomers as possible. But when the flow of depositors decreases and there is nothing to pay off the promised money, the pyramid scheme inevitably collapses. Not everyone has a chance to get their money back, not to mention the promised interest. The last ones who entered the pyramid scheme are unlikely to see their money. The organizers can hold off payments for

some time, and then collect all available savings and hide.

The Central Bank of the Russian Federation named the signs of pyramid schemes that should alert depositors:

- there is no license from Barca of Russia for investment or brokerage activities;
- the promise of high profitability - several times higher than the rates on bank deposits;
- income guarantee, which is prohibited on the securities market;
- a lot of advertising in the media and the Internet;
- no information about assets, income and expenses;
- members receive payments from the money contributed by new contributors;
- there is no expensive property;
- it is not clear what exactly the organization is doing.

If an organization falls under all the signs of a pyramid scheme that we have listed, this does not mean that it is it, but it is a signal for a thorough check of its activities by law enforcement agencies.

Along with those listed above, among other signs of a pyramid scheme, the following features of the company's work should be noted:

- payments are not related to official income;
- employees constantly use in conversation with clients the terms they do not understand from the world of finance - "forex", "stocks", "futures", "trading";
- participants' deposits are placed in foreign banks;
- it is not known who exactly runs the company;
- no office and no charter.

In the domestic economic literature, it is customary to distinguish between the following types of pyramid schemes. In our opinion, no matter how the scammers try to disguise the pyramid as an exclusive project, the pyramid will forever remain a pyramid. Usually they are usually divided into the following three types.

1. One-level pyramids (Ponzi scheme). The organizer attracts investors to his organization with a high income. And it pays off with them from the investments of new participants. In this case, all finances are concentrated in the hands of one person - the organizer. And he already disposes of them only at his own discretion, proceeding from personal interests. Usually, in such pyramids, part of the money goes to investors and part to the organizer. In this scheme, not everything is tied to attracting only new members. Often, investors who have earned a certain amount of capital invest their money in it again and again.

2. Multilevel pyramids. This type can be attributed to network marketing as well. Every newbie pays a fee. This money is distributed among the old investors. New members should bring more and more new ones. And so in a circle. Unlike the Ponzi pyramid, income in these pyramids tends to be based solely on beginners.

3. Matrix pyramids. This is a sophisticated modification of a multi-level pyramid, where a real product or service (often fictional) is present. But this is still the same pyramid scheme, so do not create the illusion that it is really profitable and useful. Especially for new members entering it [11].

Currently, in our country, as in the rest of the world, there is a positive trend in the fight against pyramid schemes. In modern conditions, the Russian Federation has deployed measures to combat the already created pyramid schemes, however, in our opinion, their activity should be suppressed from the very beginning of their creation. Pyramid schemes are most often registered as LLCs, Internet companies, microfinance institutions. Most pyramid schemes are moving their headquarters offshore. On the territory of Russia, serious measures are being taken to implement anti-offshore policy, but the organizers of pyramid schemes find omissions in Russian legislation and they often manage to register their company offshore.

Pyramid schemes cause serious damage to the Russian economy. Due to illegal financial activities, capital outflows abroad and, most importantly, poorly protected segments of the population suffer. It is quite remarkable that most of the pyramid schemes have the status of a foreign company. According to the Bank of Russia, the net capital outflow from the Russian Federation in 2019 decreased by half compared to 2018 and amounted to 22.1 billion dollars. However, in 2020, the net capital outflow abroad compared to 2019 increased by 2.2 times and amounted to 47.8 billion dollars. The Central Bank of the Russian Federation explains this fact by the deterioration of the epidemiological situation in the country in connection with the coronavirus pandemic [6]. We are convinced that the outflow of capital from Russia is associated with an increase in government pressure on business, mainly by increasing taxes, on the one hand. And, on the other hand, the lack of support of the population on the part of the country's leadership in the context of a decrease in real incomes of the population and, accordingly, a decrease in its effective demand, which again hit business.

As we have already noted above, according to the Bank of Russia data, 278 pyramid schemes were identified in the third quarter of 2021, in total, in January-September, the activity of 424 such schemes was recorded (versus 140 in the same period last year) [12]. It seems to us that the

increase in the number of pyramid schemes is again associated with the continuing decline in real incomes of the population since the beginning of 2014 and the difficult situation in the country's economy in connection with the lockdown in order to overcome the negative consequences of the coronavirus pandemic for the country's population.

According to the Bank of Russia, on average, participants in pyramid schemes in Russia give fraudsters from 50000 to 100000 rubles, but in some cases this amount can reach 100 million rubles [11].

The main reasons for the existence of pyramid schemes, in our opinion, are:

- low level of financial literacy. People who are not financially savvy, in their desire, if not to get rich, then at least improve their financial affairs, invest money in pyramid schemes, hoping to get high profits in a short period of time, but as a result lose their money;

- omissions of Russian legislation in terms of criminal punishment of organizers for the creation of pyramid schemes. The organizers of pyramid schemes are constantly improving their activities, which allows them to remain on the market for many years to come. The Russian government, in our deep conviction, must constantly improve legislation and suppress the activities of such organizations on the way to their creation.

Summing up all of the above, we state that the inevitability of the collapse of any pyramid scheme is obvious.

Having exhausted all the possibilities for the influx of new clients, the financial resources of this structure begin to gradually deplete and are no longer able to provide high payments to all their depositors. As a result, there is a significant mismatch between the constantly growing financial liabilities and the steadily decreasing monetary base. It often happens that after half a year the organizers are unable to make the promised payments and clients lose their investments.

Meanwhile, financial liabilities are increasing rapidly, while there is practically no inflow of funds. In these conditions, depositors begin to feel anxiety about the safety of their funds. In their midst, various negative rumors, frightening forecasts and panic moods appear. Most investors begin to get rid of their securities issued by the organizers of the pyramid scheme, which leads to a sharp drop in their market value and almost complete depreciation. As a result of the inability to maintain the level of liquidity and market value of "securities", the pyramid collapses.

Recently, the activity of fraudsters has also been distinguished by the creation of many "small pyramids" working "under one roof". They may have related names, common recognizable details, but the main thing is

that all payments go to one pocket or to several related scammers. This form is used, among other things, in order not to draw the attention of the Bank of Russia and law enforcement agencies to its activities.

Recently, some pyramid schemes are actively using cryptocurrencies. In modern conditions, most pyramids attract money with the help of cryptocurrency or under the guise of investing in it, said Valery Lyakh, head of the Department of Countering Unfair Practices of the Bank of Russia. Such Internet projects offer to make money with the help of unique traders who can multiply your money in a very short time. This is a classic story of financial fraud, only it is sold under the guise of investments in the stock market or other financial instruments, investments in the crypto market, he stated. The high volatility of the cryptocurrency, naturally, also attracts people who see that yesterday it cost, for example, 1000 dollars per unit, and today it is already 5 times more [10].

The most important thing is that as soon as citizens transfer cryptocurrencies or money for cryptocurrency to such Internet projects, these funds immediately end up in fraudsters' wallets.

In passing, we note that the introduction of cryptocurrencies into the Russian payment system, in our opinion, poses a real threat to the stability of the Russian financial and credit sphere. Imagine that, along with the official means of payment - the Russian ruble, a parallel currency will start to be used in the country, which has extremely high volatility and has no collateral other than supply and demand, which are easy to manipulate by cryptocurrency speculators. Along with this, in the conditions of the arrest of the monetary resources of Russian corrupt officials in the banks of Western countries, cryptocurrency becomes a convenient tool for withdrawing capital from the country. As a result, the Central Bank of the Russian Federation inevitably faces difficulties in pursuing the national monetary policy.

Recently, the Bank of Russia has begun to use the regional model to identify and eliminate illegal participants in the financial market, including pyramid schemes. In the main departments of the Bank of Russia, which are located in the capitals of federal districts, departments have been created to counter and eliminate illegal financial activities. In addition, Centers for combating illegal financial activities have been created in Krasnodar and Khabarovsk. They are engaged in the aggregation of information and analyze illegal financial organizations. Information obtained from open sources, from consumer requests and from advertising materials is analyzed to identify the initial signs of a pyramid scheme and, if found, is sent to special authorized bodies for further consideration and appropriate measures [9].

Despite the tightening control of the Central Bank of the Russian Federation over the activities of financial organizations, pyramid schemes continue to appear on the territory of the Russian Federation. Of course, for this they use all the new methods of camouflage. However, there is still a positive trend in the fight against pyramid schemes not only in our country, but throughout the world, and the reason for this is the measures taken by the central banks of the countries and the increase in the financial literacy of the world's population.

Based on what is stated in this article, we can conclude that pyramid schemes cause significant harm to both the development of the Russian banking system and the economy of the state as a whole. Classical banking assumes that commercial banks mobilize the financial resources of the population in deposits with their subsequent placement in loans to enterprises and organizations on terms of repayment, maturity and payment. Pyramid schemes also work mainly with the population. However, the money they attract, as a rule, is not invested anywhere, but is simply withdrawn from the country, that is, the organizers of pyramid schemes are really enriched.

Since the activity of pyramid schemes inevitably ends with their collapse, then among the people who have lost their money are quite significant segments of the country's population. The situation is aggravated by the fact that the activity of pyramid schemes is intensified in times of serious economic crises. It is at this time that the population easily succumbs to aggressive advertising promising large incomes in a short time, and recklessly carries its often last money into pyramid schemes. The activities of the latter are carried out with such a wide coverage of the population that often, in the context of the economic crisis in the country, this threatens a serious social explosion. That is why the country's leadership, in our opinion, should pay the utmost attention to the fight against the pyramid builders.

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AMERICAN EXPERIENCE IN IMPLEMENTING THE CONCEPT OF RELATIONSHIP MARKETING IN THE BEEKEEPING INDUSTRY

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Abstract. The article assesses the experience of implementing the concept of relationship marketing in the beekeeping industry in the United States through the creation of professional associations of farms. Some characteristic features of sectoral interactions of small enterprises of the agro-industrial complex with other market participants are highlighted, an analysis of honey marketing channels through cooperative enterprises is carried out. Based on the results obtained, appropriate recommendations were given to improve the efficiency of beekeeping development in the regions of honey-producing countries.

Keywords: agro-industrial complex, association, cooperation, relationship marketing, honey, beekeeping, bee family

The concept of marketing management of relations of small businesses with other market participants as a factor in increasing the state and regional competitiveness of the agricultural sector is a characteristic feature of the modern innovative economy. The interdependence and interconnection between cooperative processes, increasing the competitiveness of agricultural products and stimulating innovation is a new economic factor that allows private farms to resist the pressure of global competition and properly comply with the requirements of national and regional development programs for the agro-industrial complex. Hence, the marketing of relations in the agricultural sector can be defined as a purposeful process of building relationships between economically related agricultural producers and industrial enterprises, as well as scientific institutions geographically located in one territorial unit and involved in a common production and logistics chain, creating competitive products and services, the implementation of which increases their individual profit, reduces transaction costs, etc. At the same time, for the branches of agriculture (including beekeep-

ing), the production structure of which is dominated by the private sector, the formation of the concept of marketing relations occurs through cooperation, the speed of development of which is directly proportional to the number of cooperatives (associations) of farmers functioning in the industry, around which complex processes of development of a chain of inter-firm relations and management of partnership interactions. Therefore, the relationship marketing model in the beekeeping industry has the configuration shown in figure 1.

Internal environment
(Internal relations)

Members of the association

Salaried personnel (employees)

Consumers

ASSOCIATION

Suppliers of goods and services

Other market participants

Competitors

External environment
(External relations)
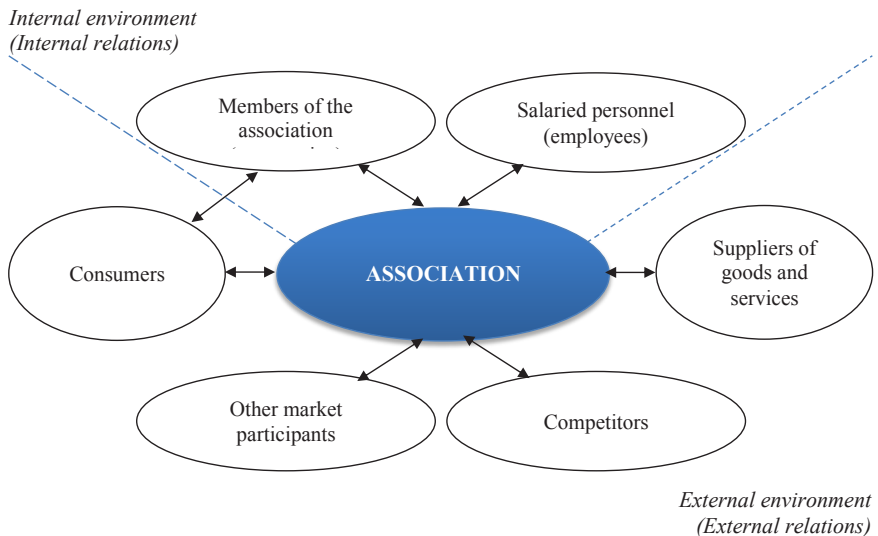
Figure 1. Relationship Marketing Model Configuration in the Beekeeping Industry (compiled by the author)

Consider the sectoral characteristics of the functioning of beekeeping, as well as the dynamics of the sale of its products, the coordination and economic mechanisms of interaction between farms and industrial enterprises, the development of the social and production infrastructure of the industry in the USA, where a system of cooperative relations of various levels has been formed in beekeeping, and the industry's annual contribution to the national economy is estimated at 15 billion dollars.[3].

In 2020, due to restrictions associated with the coronavirus pandemic, a number of restrictions were formed in the national production of beekeeping products: 1) a disruption in the supply of breeding material from New Zealand, Chile and other countries; 2) a shortage of seasonal workers

from Latin America; 3) the closure of farmers' markets; 4) difficulties with the material and technical support of farms and the provision of bee colonies with feed. Ultimately, this led to the fact that, according to the statistics of the US Department of Agriculture [9], most of the economic indicators of the industry in 2020 were lower than in 2019, but the volume of honey imports increased to cover the internal deficit (tab. 1). The main importing countries of honey for the USA in 2020 were: Vietnam (50 thousand tons), Argentina (40 thousand tons), India (37 thousand tons), Brazil (34 thousand tons) and Ukraine (11 thousand tons) [2].

Table 1.

Dynamics of changes in the main indicators of the beekeeping industry in the USA in 2019—2020 (compiled by the author based on [1, 2, 4, 5, 9])

№	Indicators	2019	2020	Changes in 2020 compared to 2019 (%)
1	2	3	4	5
1	The number of beekeepers employed in the industry (thousand people)	103	97	-6
2	Number of bee families (million pcs)	2.9	2.8	-3
3	Commercial honey production (thousand tons)	74	68	-9
4	Honey export volume (thousand tons)	7	9	+29
5	Honey export value (million dollars)	20	26	+30
6	Import volume of honey (thousand tons)	189	197	+4
7	Honey import cost (million dollars)	430	442	+3
8	Productivity of marketable honey per 1 hive (kg)	25.5	25	-2
9	Average number of bee colonies per 1 beekeeper (pcs.)	27	30	+11
10	Average per capita honey consumption (kg per year)	0.78	0.83	+7
11	Purchase price of honey (dollar/kg)	4.9	5	+2

Due to the decrease in the number of bee colonies, the cost of pollination services increased by about 4 times. So in 2020, the rent for one hive rose to 250 dollars [4, 5]. It is noteworthy that for pollination of 0.5 hectares

of land, 2 bee colonies are required, and the period of pollination of agricultural crops lasts only 3 weeks.

Due to the high labor productivity achieved through the unification, mechanization and automation of beekeeping processes, the production of commercial honey in the United States remains at the level of 70-75 thousand tons per year [1, 2, 9]. An important role in maintaining the stability of the production of beekeeping products is played by the group association of farmers in associations, mainly on a territorial basis. There are over 200 associations and other unions of beekeepers in the United States. A key role among them is played by two national organizations - the American Beekeeping Federation and the American Association of Honey Producers, as well as regional beekeeping associations: East, West, Central, as well as the association of honey processors The True Source Honey (tab. 2). Since the mid-1980s, there has been a need for a centralized promotion of honey at the national level and for the coordination of interaction between the actors of the beekeeping industry. Therefore, in 1987, the US Department of Agriculture, together with farmers, created the National Honey Council. The budget of this organization is about 3 million dollars per year and consists of deductions from entrepreneurs in the amount of 0.01 dollars for every 500 grams of domestic or imported honey with which they operate.

The aforementioned beekeeping associations are non-profit public organizations, whose budgets are formed exclusively from membership fees, and their main purpose is to bring the problems and interests of their members to the attention of the federal government; to protect and develop the national beekeeping industry and the market for beekeeping products; control of the quality of honey that gets "on the table" to American consumers.

Table 2.

**A group of active associations in the US beekeeping industry
(compiled by the author based on [4, 5, 6, 7, 8, 10, 11, 12])**

The name of the association (union) of beekeepers	Year of foundation	Organizational and legal form	Geography of presence	Purpose of activity	Association membership base, people
1	2	3	4	5	6
American Beekeeping Federation (ABF)	1943	NPO	The whole territory of the USA	Bringing the interests of members to the attention of the authorities, promoting the development of the American honey market, monitoring the quality of honey, promoting the beekeeping insurance program.	>1500
American Honey Producers Association (AHPA)	1973	NPO	The whole territory of the USA	Promotion of the common interests and the general welfare of honey producers.	>1000
Eastern Apicultural Society (EAS)	1955	NPO	New York, Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, Delaware, Maryland, Kentucky, Tennessee, Virginia, West Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi and the District of Columbia, as well as Ontario, Quebec and the Canadian Coastal Province	Promotion of the beekeeping industry, beekeeping training, skills certification and cutting edge research in beekeeping.	> 1000

1	2	3	4	5	6
Western Apicultural Society (WAS)	1978	NPO	Alaska, Arizona, California, Hawaii, Colorado, Idaho, Utah, Montana, Nevada, New Mexico, Oregon, Washington, Wyoming, and Alberta, British Columbia, Yukon, and Saskatchewan	Expand resources for training beekeepers and develop industry partnerships with scientists, professionals and industry leaders in the western United States.	>900
Central Apicultural Society (HAS)	2001	NPO	Central region. (states of Wisconsin, Indiana and Kentucky and other states)	Providing the industry with the latest beekeeping knowledge and courses for beginner and advanced beekeepers in the Central States.	> 400
Sioux Honey Association Cooperative (SHAC)	1921	APC	The whole territory of the USA	Providing beekeepers with equipment and resources so that they can increase production and supply of quality honey to national and regional markets.	>200
True Source Honey (TSH)	2010	NPO	Regions of the USA and Canada, Argentina, India, Vietnam, etc.	Created by American honey producers, processors and packers to draw attention to the problem of illegal obtaining honey from other countries (especially from China)	>750
National Honey Board (NHB)	1987	NPO	The whole territory of the USA	Development of beekeeping, informing the population about the benefits of using beekeeping products for food, monitoring their quality in the domestic market.	>300

Analysis of the distribution channels showed a fairly short honey route; a significant part of it is sold by American beekeepers through intermediaries, which are most often companies engaged in the packaging and packaging of honey. Let us consider an example of such interaction "farm - intermediary enterprise - consumer" on the example of the functioning beekeeping cooperative "Sioux Honey Association Co-op" for many years, the main activity of which is the procurement, processing, packaging of honey and its subsequent sale under its own label (fig. 2). This cooperative system is multifunctional and covers the entire territory of the United States, unites more than 200 beekeepers, and it accounts for more than 25% of the country's honey operations [8]. At the same time, the peculiarity of this business model is to preserve the independence of family farms, and decisions are made in a democratic way at a general meeting of cooperators. The company strives to produce only the highest quality cooperative honey, and then sell it under its own brands Sue Bee (classic honey) and Aunt Sue (raw and unfiltered honey) for any application [8]. Therefore, honey is purchased from farms in strict accordance with the quality protocol, and sometimes with the involvement of services from the non-profit organization The True Source Honey to independently control the quality of honey from the supplier. In the future, the company processes, packs and packs honey in designer small containers with a volume of no more than 500 grams [8]. At the same time, American consumers, unlike Russian ones, prefer liquid honey, and its natural crystallization is considered an indicator of poor quality. In the future, the sale of finished products occurs mainly through the Amazon electronic trading platform or directly through its own network of retail outlets.

In the United States, there is a close relationship between the beekeeping community and other sectors of the national economy, as well as the federal government through associations, which effectively develop a multi-level system of cooperation between small businesses and other market participants, which allows for a balanced combination of government regulation, market laws and modern forms of cooperation relations between business entities. Hence the development of beekeeping in the regions of honey-producing countries, it is necessary to start with improving the market relations of the subjects of the beekeeping industry with other sectors of the national economy; eliminate the shortage of qualified specialists; to increase the number of large specialized beekeeping farms with the production of products on an industrial basis; to raise the level of automation and mechanization of farms; focus on the development of the industrial and social infrastructure of the industry through the creation of

regional cooperative cluster platforms that allow managing relationships and coordinating the actions of stakeholders. The current economic situation on the national market in the United States, where there is an increase in demand and a shortage of honey, can serve as a motive for the export-oriented direction of the industry's development in honey-producing countries.
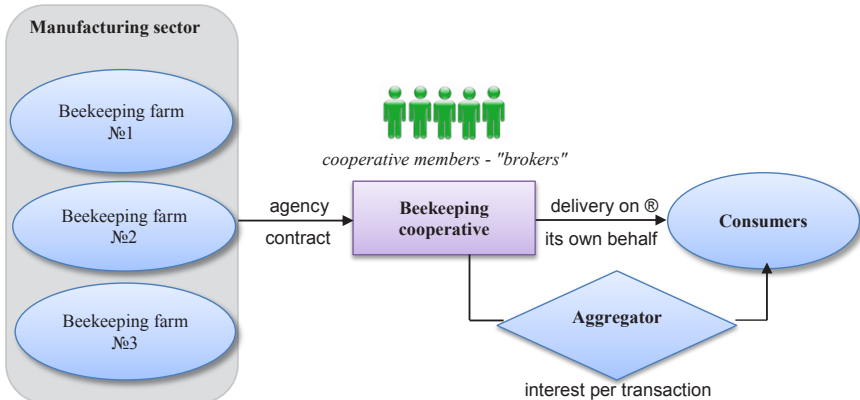
Figure 2 — The path of honey from an independent producer (farmer) to a consumer through cooperative relations in the USA (compiled by the author)

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CREATIVE FOUNDATIONS OF RESOURCE FLOWS FOR HEALTHCARE

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Abstract. The article examines the key problem of Russian health care, which consists in insufficient resource provision for effective development in accordance with the needs of the population. It is noted that various models of reforming the system over the past decades have not led to overcoming the lack of limited resources in the industry. At the same time, the existing scientific proposals for sufficient resource provision for the development of health care do not contain an effective solution that would radically correct the current situation. As a way out, the priority of ecosystems in the development of the healthcare sector is proposed, on the basis of which the creative integration of all financial flows is possible by direct selection of the total number and structure of medical services by the citizens of the country.

Keywords: healthcare, healthcare spending, creative economy, digitalization of the economy, ecosystems.

The main problem of the resource provision of Russian healthcare for many decades has been the chronic inadequacy of allocated funds. In the Soviet era of the planned economy, this was qualified as a residual principle of financing and the leadership recognized the fact that the development of medical organizations was lagging behind in comparison with the then already existing capabilities of medicine itself. [16, 173-174]

In the post-Soviet period, numerous reforms were carried out in the Russian Federation, as a result of which and in accordance with market principles of economic development in health care, the industry was decentralized, private organizations were formed, and compulsory health insurance (CHI) was introduced. Russian healthcare has ceased to be an exclusively budgetary sphere. [14]

In the past two decades, a number of large federal projects and pro-

grams have been implemented in the health care of Russia. Together, this made it possible to reorganize the network of medical institutions by combining many polyclinics into large medical centers, to provide state medical institutions with the right to provide paid services to the population, to establish resource support through territorial programs of state guarantees, integrating compulsory medical insurance and additional budgetary funding.

However, in spite of reforms of different content, carried out in different socio-economic conditions and for quite a long time, the level of resource provision of health care remains low. This is clearly seen when comparing similar indicators with other countries of the world. [8]

Of course, the functional role of health care and its place in socio-economic development is determined not only by the quantitative indicators of allocated resources, but it is in these indicators that the direct relation to the industry and the population and the state is manifested.
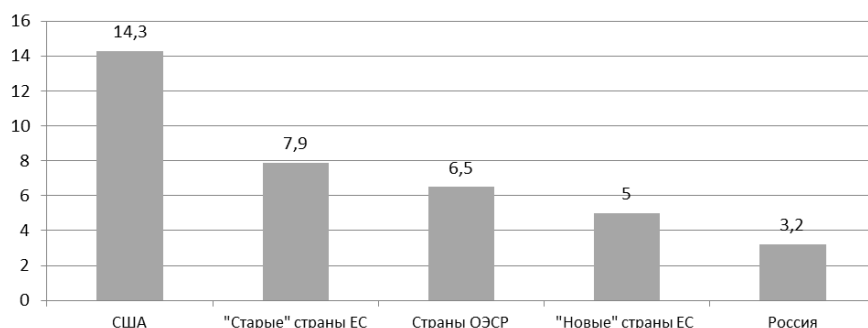
Figure 1. Government spending on health as a percentage of GDP for selected groups of countries and the Russian Federation in 2018 (compiled by the author based on: 2, 154; 15, 8)

As can be seen from the data in Figure 1, the level of government spending on health care in the overall structure of used GDP in Russia lags several times behind the indicators of other countries, and if we consider it in relation to the USA, it is almost 4.5 times. At the same time, the share of health care expenditures in the overall structure of Russian GDP use is also significantly lower (fig. 2), and more than a threefold gap remains relative to the level of the USA indicators.

Russian scientists and specialists pay special attention to this fact, and most of the proposals for the further development of health care in one way

or another relate to this issue. [11] A joint report by the Center for Strategic Research and the Higher School of Economics substantiates the need to increase government spending to 4 percent of GDP by 2024. [15] A more significant increase in spending is proposed by specialists from the Higher School of Health Organization and Management, noting the need to almost double public spending - to 6 percent of GDP in the next 2022. [10]
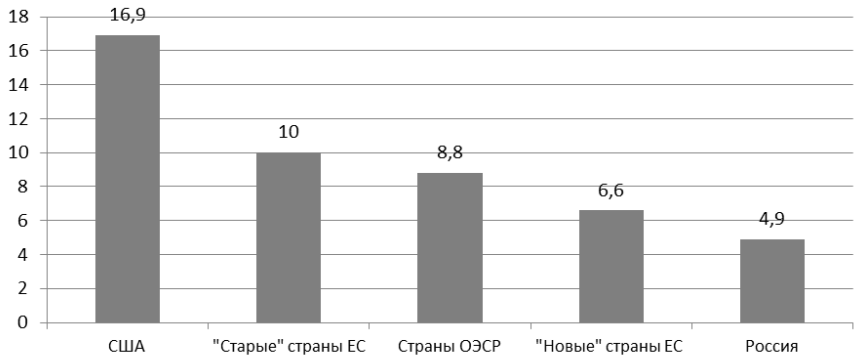
Figure 2. Total health spending as a percentage of GDP for selected groups of countries and the Russian Federation in 2018 (compiled by the author based on: 2, 154; 15, 8)

The consequences of the global coronavirus pandemic have become an additional argument for increasing resources allocated to health care. At the same time, the existing proposals for increasing costs are also far from the world level. Moreover, the OECD countries envisage an increase in the share of health care expenditures by more than 10 percent of GDP in the near future. [5] Therefore, even if the proposals of Russian specialists are implemented to one degree or another, the lag in terms of world criteria will persist.

The recently adopted "National Healthcare Project" in the Russian Federation does not solve the problem either. The fact is that the total amount of finance provided for its implementation is slightly more than one percent of GDP, and in case of a forced prolongation of the implementation period until 2030, it will be generally less than one percent. [6]

In such conditions, in our opinion, it is advisable to search for a solution to the problem in new economic relations that are formed under the influence of the processes of creativity and digitalization of the national economy.

The doctrine of the creative economy originates from the presentation of the priority components of entrepreneurship - technology, talents, tolerance - as the backbone factors of the new economy. [12] Further development proceeded along the line of presenting creative entrepreneurship as a leading segment of national economies and the global economy. [13]

A notable interpretation of the creative economy was the identification in its content of the advanced growth of new technologies, when the main reproductive task was the transformation of the growing volume of knowledge into goods and services demanded by the market. [1]

Currently, the creative economy is mainly interpreted as a form of post-industrial socio-economic development. This is based on the priority of the intellectual principle of the main factors of production - labor and capital. [7]

An important direction in the development of the theory of creative economics is its integration with the content of the digital economy. First of all, because both are based mainly not on hierarchical economic relations, but on non-competitive partnerships. It is this kind of mutually supportive cooperation and development that is becoming one of the leading drivers of the global economy. [4]

In the digital component of modern development, a special role is assigned to the diffusion of ecosystems. [3] The technological capabilities of ecosystems, in turn, are the basis for the priority reproduction of industries focused on the development of human capital - education and healthcare, and not on market principles. In addition, the noted capabilities of ecosystems make it possible to turn the citizens of the country directly into the main managers of the corresponding budgetary funds. Accordingly, budget funds, being concentrated on targeted accounts of citizens, will be used in accordance with the real consumer preferences of households, which will become a key creative basis for the formation of resource flows in health care. Similar proposals have previously been made in relation to higher education reforms. [9]

Thus, the development and formation of the ecosystem of the health-care sector opens up the possibility of integrating all financial flows through the direct choice of the total amount and structure of medical services by the citizens of the country through the target demand of households. This will make it possible not so much to solve quantitatively the contradiction in resource provision of health care, but to creatively optimize the corresponding expenditures of GDP in accordance with the preferences of the population.

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HEALTH CAPITAL UNDER THE CONDITIONS OF THE PANDEMIC[1]

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Abstract. The aim of the work is to conceptualize health capital in a pandemic. The health capital is represented in the unity of six basic measurements. The results of an expert assessment of health capital in a pandemic are shown

Keywords: health capital; pandemic; Russian healthcare field

The concept of human capital, popular in economics, has become transdisciplinary in recent years, increasing its content components and explanatory potential. At the center of our reasoning is health capital as a pivotal factor of human capital.

Health is understood as a resource of human activity, creative activity - it is in this capacity that health is most often analyzed in the structure of human capital (Moseiko 2012). In the works of M. Grossman - the author of the concept and term - the capital of health is presented in the categories of the supply of life, accumulation, goods / durable goods that we spend and accumulate in the processes of production and consumption. With age, the value of health increases, and, as a rule, a person begins to purposefully invest in his physical, mental, social, spiritual self (Grossman 1972a, 1972b, 2000). A. Sepehri (2015) provides a systematic critique of the classical ideas of health capital. The author notes that the model is widely used in health research, socioeconomic inequalities in health, health care measures, and professional careers. At the same time, the Grossman model is based on erroneous conceptual frameworks and assumptions about a high degree of consumer / patient control over their health status and the

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possibility of survival. A. Sepehri believes that Grossman's individualistic and mechanistic view of health deprives health capital and its production of biological / physiological content and interaction with the social and physical environment of a person (A. Sepehri 2015).

Note that the important lines of addition or criticism of Grossman are the ideas of introducing and enhancing the importance of intangible components in the structure of human capital. Interesting works on emotional capital, psychological capital, accentuating the importance of the corresponding components in increasing the financial return from work, in the reproduction of gender mechanisms for the division of domestic labor (Luthans, Vogelgesang, Lester 2006, Parcel, Hendrix, Taylor 2016)

It is especially important for us to note that the capital of health is inscribed in the social and cultural framework, becoming a kind of projection of a person's life scenarios in the corresponding social environments and cultural circumstances.

Summarizing the results of various disciplinary studies, D.I. Aslanov identifies nine topological properties and signs of health as human capital (Aslanov 2011, p. 205-206). On their basis, we have identified six main measurements of health capital (table 1).

Table 1
Topological properties and signs of health as human capital

Individuall - value measurement of health capital.	National (universal) measurement of health capital	Temporal measurement
Health capital is the foundation of human capital Investing in health prolongs the life and time of use of human capital Health as capital is not subject to impairment. Health can be depleted, depleted, but it will never lose its value for a person	Health capital is a national treasure, as it determines the productivity of social labor and the characteristics of social development.	Human health, as capital, does not bring its owner instant (quick) income and requires the diversion of significant funds, often to the detriment of current needs.

Consumer measurement	Risk measurement	Responsibility and lifestyle as a measurement
The capital of health is both a good produced on the basis of reserves and a resource on the basis of which goods are produced. Moreover, the capital of health is a blessing of long-term, but limited use due to physical and moral deterioration. Human health remains a person's capital even if he does not realize it, i.e. does not engage in activities.	Human health, unlike education, cannot be acquired or restored in a short time. Moreover, the capital of human health accumulated over a lifetime can be instantly destroyed due to emergencies.	The state assumes the obligation to ensure the rights of citizens to health, but the person himself bears responsibility for the actual state of health. The lifestyle that a person leads, his attitude to nutrition, physical activity, labor activity, social contacts, opportunities for self-realization significantly determine the characteristics of his health.

The multidimensionality of health capital, its projections into activities, social activity, emotional connections allow us to interpret health as a kind of assemblage point for various aspects of human capital, a symbolic intersection of institutional, organizational, and communicative flows.

A huge role in the accumulation and conversion of health capital is played by the social sphere in general and health care in particular. Moreover, within the framework of Russian modernization and optimization processes, it is the institute of health care that is endowed with responsibility for mortality and fertility, prevention and treatment, preservation and accumulation of health capital in specific territories of Russia.

The latest statistics paint a disappointing picture: in January-August 2021, mortality outstrips births in almost all regions.

The capital of health is provided by the systemic interaction of social agents: to one degree or another, this is influenced by the citizens themselves; medical organizations of various forms of ownership - with their culture, technologies, personnel, management practices, financial solvency; alternative medicine organizations, healers; medical equipment suppliers and pharmaceutical companies; TFCHI and insurance companies; educational organizations; courts; the state, including control and supervisory authorities; various intermediaries, including media structures; public associations; volunteer solidarity; human rights organizations, public asso-

ciations of patients or their relatives; professional associations. Multilevel communications about health are built in the general mainstream of the ingrained cultural patterns of patients: readiness for paternalism; lack of compliance (sometimes its absence); hope for a magic pill and a quick cure; distrust of budget medicine; focus on past experience of successful self-medication and self-prescription of medications; as well as the popularity of administrative methods of restoring justice - complaints.

A huge role in ensuring the control and standardization of the practices of interaction between citizens and medical organizations is played by Rosszdravnadzor, whose main activity is state control of the quality and safety of medical activities. In 2020, the work of Roszdravnadzor was adjusted by changes made by the Government of the Russian Federation in connection with the spread of a new coronavirus infection. As a result of monitoring and verification activities, it was established that in all constituent entities of the Russian Federation, with the exception of the Republics of Altai, Buryatia, Ingushetia, Karachay-Cherkessia, Komi, Mari El, North Ossetia-Alania, Tatarstan, Tyva and Chechen, Altai Krais, Voronezh, Kaluga, Lipetsk, Rostov, Tambov and Tomsk Oblasts, the city of Moscow, the Jewish Autonomous Oblast, Nenets, Khanty-Mansi-Yugra, Chukotka and Yamalo-Nenets Autonomous Districts, there were cases of closure of medical organizations (their structural units) that did not participate in the provision of medical care patients with COVID-19, quarantined (lasting from 14 to 21 days) in connection with the detection of COVID-19 disease in employees or patients (On the results ... 2020, p. 9)

The closure of medical organizations (their structural subdivisions) negatively affected the availability of medical care to patients in the Republic of Bashkortostan, Zabaikalsky Krai, Ryazan Oblast (failure to meet the deadlines for the start of providing specialized medical care to patients in the "oncology" profile), Nizhny Novgorod Oblast (failure to comply with hospitalization terms and shorten inpatient treatment of patients with acute coronary syndrome and acute cerebrovascular accident, as well as the availability of specialized medical care for citizens), Sakhalin, Sverdlovsk Oblasts (non-compliance with the terms of routine surgical care for patients), Smolensk, Tverskaya, Tula and Yaroslavl Oblasts (availability of specialized medical care for citizens). The checks also revealed violations in the routing schemes; non-observance of the terms and volume of dispensary observation of patients with chronic diseases; cases of non-compliance with waiting times by patients, inadequate equipping of medical organizations with medical equipment; cases of non-conducting of telemedicine consultations with federal and regional remote consulting centers

of anesthesiology and resuscitation; the lack of additional training for medical personnel in the implementation of measures to prevent and reduce the risks of the spread of a new coronavirus infection (On the results ... 2020, p. 9-18). The results of inspections indicate the risks of a significant decrease in health capital in individual regions and in Russia as a whole.

According to Rosszdravnadzor, the number of citizens' complaints dissatisfied with the quality of medical care provided is growing every year. The reports for 2019 and 2020 provide the following data: in 2018, 89,751 were registered, in 2019 - 95,518 applications from citizens. In 2020, 131,144 appeals were received from both individual citizens and organizations, of which 48573 were sent to the central office, 82,571 to the territorial bodies of Roszdravnadzor in the constituent entities of the Russian Federation. In comparison with the previous year, the number of appeals received by the central office increased by 44%, to the territorial bodies of Roszdravnadzor - by 33.7%. The content structure of calls is presented in table 2.

Table 2

Content structure of complaints and appeals to Roszdravnadzor in 2020

№	Content of the appeal	Number of appeals (in%)
1.	Organization of medical care	43.4
2.	The quality of medical care	33
3.	Observance of the rights of citizens in the field of health protection	27
4.	Unskilled actions of medical personnel, as a result of which the patient's death occurred	9.8

Source: On the results of the work of the Federal Service for Surveillance in Healthcare in 2020, plans for 2021 and the planned period https://roszdravnadzor.gov.ru/

The number of complaints in connection with the work of pharmacies and the provision of medicines increased: citizens complain about the lack of medicines in pharmacies (64.2%), the doctor's refusal to prescribe medicines (22%), long-term deferred servicing of preferential prescriptions (9.6 %), inadequate provision of patients with anesthetic narcotic drugs (2.9%). In the context of the spread of the new coronavirus infection COVID-19, the majority of citizens (76%) cited the facts of the absence of personal protective equipment, including disinfectants and medical devices - medical masks, the absence of drugs for medical use in the pharmacy sale.

As before, the Roszdravnadzor free hotline for the observance of citizens' rights in the field of health protection was open around the clock. Prompt decisions were made in about 33% of requests within 24 hours.

The 2020 pandemic has significantly changed not only the communication in the healthcare field, but also the very configuration of work and everyday life. According to Rosstat, the average per capita money income of the population in the 2nd quarter of 2020 decreased compared to the same period in 2019 from 34,513 to 32,854 rubles per month. The size of the population with cash incomes below the subsistence level in the whole of the Russian Federation in the 2nd quarter of 2020 increased compared to the same period in 2019 from 18.6 to 19.6 million people (On the ratio ... 2020).

A survey of Russians on satisfaction with medical services conducted by the "Romir" holding in September 2020 showed that citizens with a high level of income are more satisfied with the quality and accessibility of medical care compared to low-income groups (59% of respondents with low income rate the quality of medicine as poor or very poor, in the group of highly profitable such assessments were given by 25% of respondents). Note that the survey involved 1,500 respondents over 18 years old from all types of settlements in all constituent entities of the Russian Federation. The good news is that even despite the coronavirus, a sufficient number of Russians are satisfied with their state of health - they turned out to be 71%. In 2003, only 52% of those surveyed were satisfied with their health. Another conclusion from the "Romir" poll is that the consumer image of Russian medicine is worse than the real situation in healthcare (Russians ... 2020).

As part of the PRO Socium Program, which the Presidential Academy conducts in 27 regions of the Russian Federation, a comprehensive study of the social sphere was carried out, including a survey of participants.

PRO Socium program:

• aims to synchronize the work of regional project teams with the position of federal authorities in the implementation of national projects

• implements cross-sectoral and interdepartmental approaches in teaching students to design and project management

• practices a team approach

• provides cascading of national goals, taking into account regional specifics, including the municipal level

• has a built-in screening research program that allows you to record the input level, intermediate changes and the results of the design of regional social systems.

326 people took part in the survey (the method of available sampling), of which 23.9% were men and 76.1% were women. Most of the participants work as leaders or leading specialists in state budgetary institutions (61%), in state authorities (17.8%) and local government (14.4%).

In the context of a pandemic and the increasing risks of destruction of human capital, respondents point to the urgent need to combine public efforts and attract additional funds to the region. This is especially true in the following areas: health care, improvement, employment, transport infrastructure, housing and housing affordability, utilities. It is obvious that in the current situation in all regions the health problems are the most acute. A separate open-ended question related to what the respondent personally assesses as negative consequences of the pandemic. The most popular answers related to both objective and subjective aspects (table 3).

Table 3.

Objective negative consequences	Subjective negative consequences
Loss of stability Reduction of mass events Job cuts the older generation was not ready for a pandemic due to the fact that they have a low command of technical means. Rise in prices Unemployment overloading the healthcare system Decrease in the level of income of the population The purchasing power of citizens has decreased Small business was hit hard. Health of people, loss of loved ones Loss of civil rights and freedoms Divorces Growth in accounts payable in medical organizations, growth in prices for drugs Restriction of movement as a factor in reducing control over the functioning of enterprises	A deceiving plateau of stability Increased anxiety Mass psychoses Disunity of the population Depression and neuroses in the population Emotional burnout of healthcare workers Fear and passivity of people to attend cultural and sports events

The negative impact of the pandemic on health capital is evident. This situation is largely supported by the alarmist messages of the Russian me-

dia. Every day, Russians are informed of the number of cases and deaths, expert opinions on the insufficient reliability of the vaccine, and the conflicting positions of international organizations. But the foundations of conflicts are inherent in the system itself - medical discursive practices do not allow to correspond to the market focus on the client; the introduction of info-communication technologies and 4P medicine runs into low information literacy of staff and the population; the opposite and sometimes conflicting interests of the agents of the field are consistent in the space of wandering mists; tightening control gives rise to cunning tactics to maximize their own benefits.

The preservation and accumulation of health capital is possible only if the departmental principle is abandoned and the development of practices for holistic interagency interaction, the activation of social resources and social capital, contributing to the preservation, restoration and accumulation of health capital throughout life.

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EFFECT OF THE SEVERITY OF SEVERE CONCOMITANT TRAUMATIC BRAIN INJURY ON THE CIRCADIAN RHYTHM OF CARDIAC OUTPUT IN CHILDREN OVER 7 YEARS OF AGE

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Abstract. Regardless of the severity of injuries with concomitant trauma, a tendency to an increase in the mesor of the circadian rhythm of stroke blood volume per day was revealed in all subjects. The tendency to increase SV was relatively less pronounced in group 1 than in groups 2 and 3. An increase in the amplitude of daily SV fluctuations up to 22 ml in group 2 can be explained by a decrease in stress-protective drug correction before being transferred to a specialized department. Deformation of the phase structure of not only circadian, but also weekly rhythms with a change in amplitude, wavelength, and a shift in the acrophase peak was revealed. A tendency towards the formation of a hyperdynamic type of hemodynamics was revealed.
Keywords: circadian rhythm, mean arterial pressure, severe concomitant traumatic brain injury, children.

Relevance

The combination of TBI with damage to other organs and systems exacerbates the severity of brain damage. On the one hand, this is due to the inadequacy of systemic compensatory reactions in the shock period, and on the other hand, to direct or indirect damage to various organs or

systems. High intracranial pressure (ICP) can cause systemic hypertension, which is combined in the classical type with bradycardia (Cushing's reflex) or, almost equally often, with tachycardia. Cardiac arrhythmias are common, most commonly sinus bradycardia, supraventricular tachycardias, junctional rhythm, and heart block. T-wave inversions and ST segment changes can simulate subendocardial ischemia. In severe combined TBI, the development of traumatic disease, regardless of the localization of extracranial injuries, has a number of regular stages. In the early post-shock period, against the background of elimination of hypovolemia, a hyperkinetic reaction characterized by a hyperdynamic circulatory regime (increased one-time and minute heart performance) should be considered characteristic. However, there is not enough information in the literature on changes in cardiac output in SCTBI in children [1-5].

Purpose

To study the effect of the severity of severe concomitant traumatic brain injury on the circadian rhythm of cardiac output in children over 7 years of age.

Material and research methods

We studied the indicators of a comprehensive examination of 18 school-age patients (7-18 years old) with severe concomitant traumatic brain injury (SCTBI) admitted to the intensive care unit (ICU) of the neurosurgical department of the Republican Scientific Center for Emergency Medical Aid (RSCEMA) in the first hours after the road traffic accident (RTA) - 15, cata-trauma - 3 patients. Hourly monitoring of the SV indicator (stroke volume) was carried out by calculating hemodynamic parameters according to the formula: SV = PBP*100/AvBP in ml, where PBP is the pulse arterial pressure; AvBP - mean arterial pressure. The results were processed by the Student's method, pairwise correlations.

Results and its discussion

Table 1.

Characteristics of patients with concomitant severe traumatic brain injury over 7 years old

Groups	1	2	3
Num. of patients	4	6	7
Days at the ICU	7.7±1.7	14.8±2.2	34.6±14.1
Age, years	11.5±3	10.6±0.9	12.7±2.8
GS, points	10±0.4	8.2±0.9	7.8±0.7

ALV, days	2±0.9	10.7±2.6	22.2±4.5
PTS, points	4±0.2	1±0.3	1±0.25
ISS, points	52±8	60±13	47.8±8.5

The severity of the patients' condition was predominantly determined by the severity of the brain damage (tab. 1). In case of impaired consciousness 10±0.4 points, the severity of trauma according to PTS 4±0.2 points reduced the duration of ALV to 2±0.9 days and the duration of treatment in the ICU to 7.7±1.7 days (tab. 1).

With a comparatively less pronounced traumatic effect on the brain, timely etiopathogenetically determined measures were able to bring patients out of the state of severe traumatic shock in a fairly short time, timely surgical correction of bone fractures, effective intensive therapy of bruises of parenchymal organs, and compensation of blood loss (tab. 2). The efficacy of the treatment of severe cerebral contusion (CSA) was more favorable with open TBI, as evidenced by the shorter recovery time in group 1, 7.7±1.7 days, in group 2, 14.8±2.2 days, ALV duration in 1 group 2±0.9, in group 2 10.7±2.6 days than with SCTBI (tab.1). While the duration of intensive therapy in group 3 patients was significantly longer and amounted to 34.6±14.1 days ($p < 0.05$), ALV 22.2±4.5 days ($p < 0.05$) (tab. 1).

Table 2.

Dynamics of the mesor of the circadian rhythm of the stroke volume in the acute period of SCTBI (ml)

Days	Group 1	Group 2	Group 3
1	60.7±9.1	58.4±7.2	60.6±4.5
2	58.0±4.6	67.0±3.7	60.6±3.0
3	53.3±3.9	65.2±3.7	68.8±4.2
4	49.6±3.9	65.2±4.4	64.4±3.1
5	55.8±3.9	62.1±4.0	63.7±2.5
6	55.8±4.4	62.9±3.0	61.9±2.6
7	49.6±3.5	64.0±3.3	59.9±4.4
8	55.4±8.1	63.8±4.0	62.3±4.2

9	57.1±4.6	65.2±3.2	58.8±4.0
10		59.2±3.6	62.4±4.4
11		63.3±4.8	62.0±3.6
12		61.8±3.2	59.8±3.6
13		61.1±4.8	60.3±4.1
14		60.6±4.0	55.4±2.5
15		54.8±6.5	54.7±2.7
16		67.6±8.6	54.4±2.5
17		59.8±7.4	58.7±2.4
18			53.2±3.4
19			55.5±2.4
20			55.4±2.5
21			62.7±2.1
22			57.3±2.8
23			57.5±2.0
24			60.9±3.5
25			58.3±2.9
26			57.4±3.6
27			56.4±3.1
28			56.0±3.2
29			58.8±3.5
30			53.4±3.1

Despite the intergroup difference in the severity of injuries with con-comitant trauma, a tendency to an increase in the mesor of the circadian rhythm of stroke blood volume per day was revealed in all subjects (tab. 2).
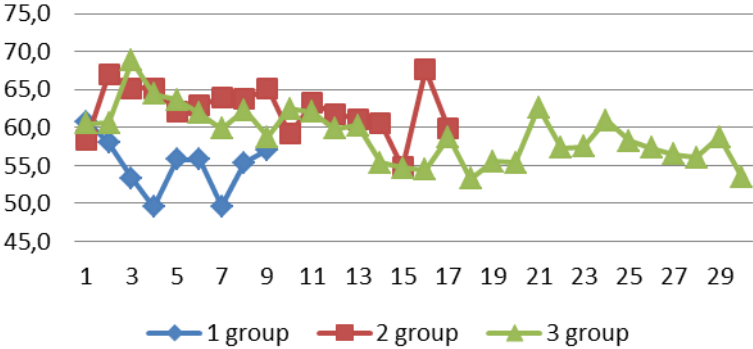
Figure 1. Effect of injury severity on stroke volume

As shown in fig. 1, the tendency to increase SV was relatively less pronounced in group 1 than in groups 2 and 3 by 15 ml on days 4 and 7, remaining less during the first 9 days. Attention is drawn to the undulating character of the dynamics of the SV mesor indicator of the circadian rhythm with a per week period of the oscillatory cycle (fig. 1).

Table 3.
Mean SV values in circadian rhythm in the acute period of SCTBI over 7 years (ml)

Hours	Group 1	Group 2	Group 3
8	55.9±7.0	62±5	57.6±4.0
9	54.1±4.8	63±4	57.6±3.0
10	55.7±4.7	63±3	59.3±5.0
11	51.1±3.2	62±6	58.5±4.8
12	52.3±6.3	62±6	58.1±4.5
13	54.0±5.9	63±5	59.5±4.8
14	54.8±8.8	61±5	58.9±4.7
15	57.2±6.7	61±5	58.9±4.2
16	57.1±7.4	61±7	58.9±3.8
17	57.8±6.8	63±6	58.7±4.8
18	52.5±5.1	65±5	57.5±4.2
19	55.2±2.4	65±3	58.8±3.6

20	52.6±4.8	64±6	59.8±3.5
21	52.9±6.5	61±6	59.2±4.0
22	54.2±2.3	60±7	61.5±4.4
23	54.6±6.4	61±5	59.7±4.2
24	53.2±4.6	64±4	60.0±4.9
1	55.3±4.9	65±5	59.2±4.6
2	55.3±4.9	63±6	59.9±4.3
3	57.8±6.2	63±6	59.2±4.7
4	57.1±7.1	62±4	59.1±4.6
5	55.6±4.2	64±4	59.1±4.3
6	52.4±4.0	63±5	59.6±3.9
7	59.3±5.4	64±5	58.6±4.9

As can be seen from the results of the study of the SV index in the circadian rhythm (tab. 3), there were no significant differences between the groups in terms of the severity of the patient's condition. However, the graphical representation of the results obtained made it possible to detect wave-like changes in SV in group 1 at comparatively lower rates (55 ml), while in group 3 daily changes occurred at an average level of 58 ml. And in group 2, ultradian waves with an oscillation period length of 7 - 7-7 hours at a higher level of SV index - 63 ml (fig. 2).
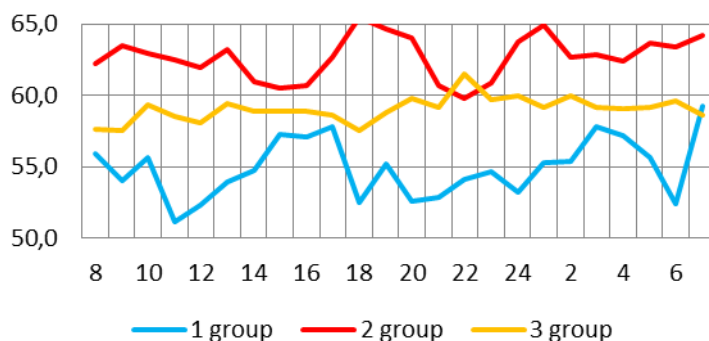
Figure 2. Mean values of SV in the circadian rhythm in the acute period of SCTBI, ml

The dynamics of the amplitude of the SV circadian rhythm is represented by the largest amplitude of fluctuations in 1 day (23 ml) in group 3 with a decrease in the following days to 8 - 17 ml. In group 2, the most pronounced daily instability was found on days 16-17. An increase in the amplitude of daily SV fluctuations up to 22 ml can be explained by a decrease in stress-protective drug correction before transfer to a specialized department. Possibly, the revealed feature in group 2 is an indicator of still not fully achieved stabilization of the state in conditions of the achieved positive effect of intensive therapy (fig. 3).
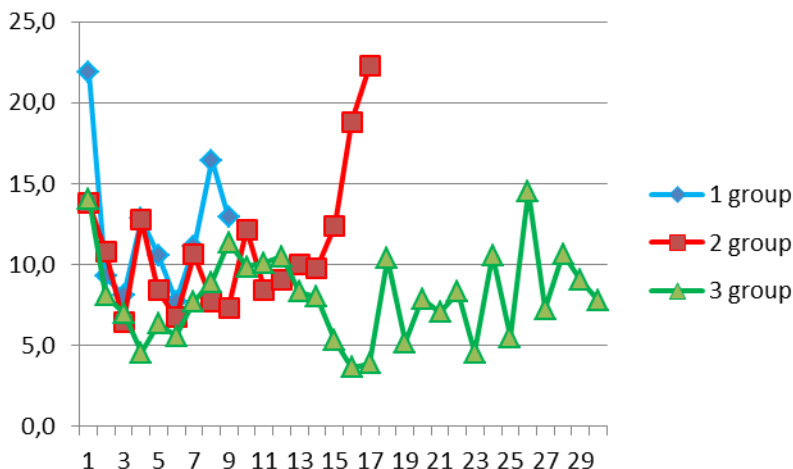
Figure 3. Changes in the amplitude of the SV circadian rhythm, ml

In group 3, diurnal SV fluctuations occurred in waves with an oscillation period of 9, 9.6, 5 days, that is, deformation and changes in the phase structure of circadian, but also weekly rhythms were observed with a change in amplitude and wavelength (fig. 3).
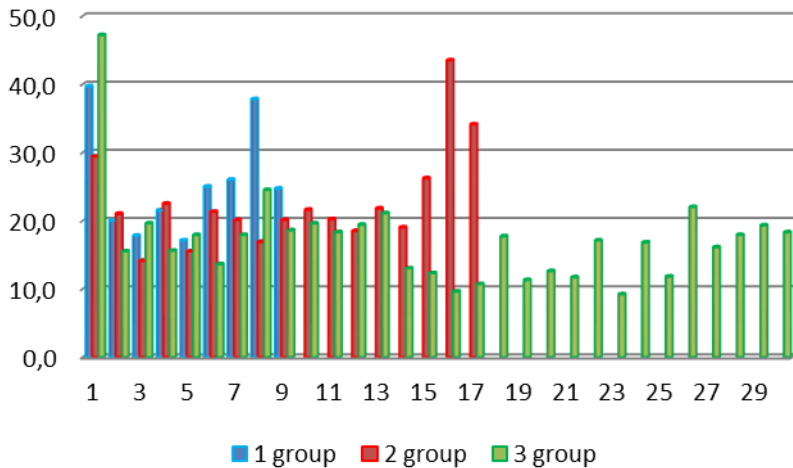
Figure 4. Dynamics of the daily range of SV fluctuations by groups, in ml

The daily range of changes in SV was 40 ml in group 1 on day 1 and 37 ml on day 8 (fig. 4). In group 2, the maximum changes in SV were detected on day 1 (29 ml) and on day 16 (43 ml). In group 3, the greatest daily changes in SV were observed on day 1, when changes in cardiac output per day amounted to 47 ml (fig. 4). The greater the change in SV during the day, the more unfavorable the state of coronary blood flow, myocardial contractility, the risk of developing heart failure increases. In this regard, it is possible to imagine the expediency of drug therapy supporting myocardial metabolism during periods of adaptation to changing conditions of the muscular system, including the myocardium in the acute period of STBI in children over 7 years of age.
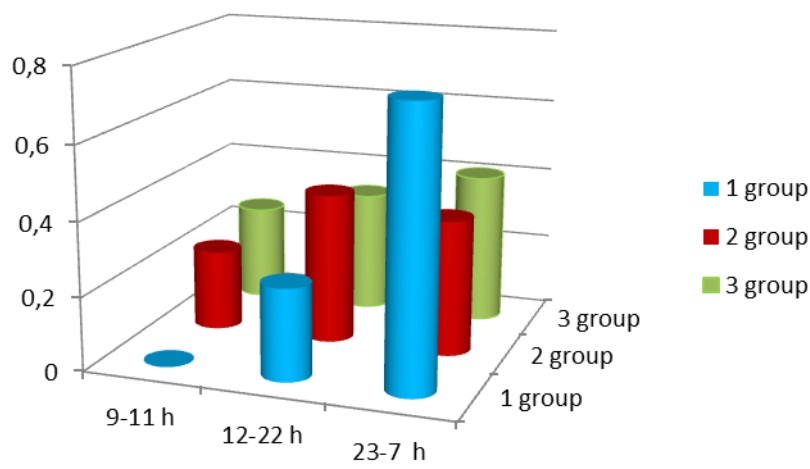
Figure 5. Duration of shifts of SV circadian rhythm acrophase by groups

Inversion of the SV circadian rhythm was the most prolonged in group 1 (57%), in groups 2 and 3, a moderate shift in the acrophase peak of the SV circadian rhythm prevailed (54% and 70%, respectively) (fig. 5).
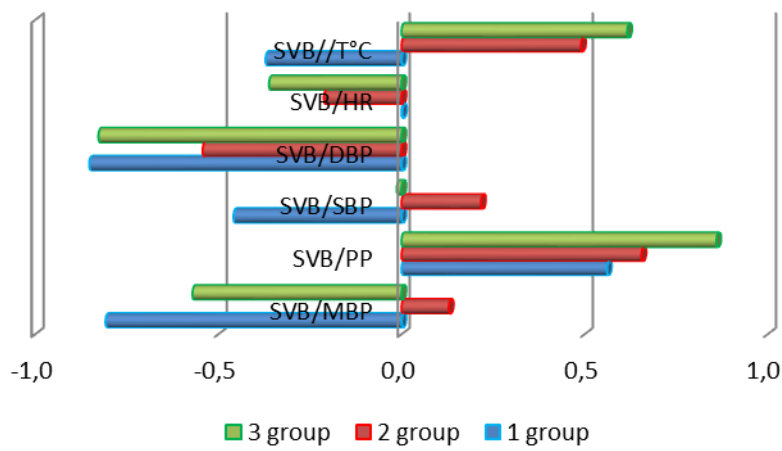
Figure 6. Dynamics of correlations of the mesor of the circadian rhythm SV in the acute period of SCTBI in children over 7 years old

In the acute period of SCTBI, there was a strong feedback of SV and DBP (-0.8), SV and SBP (-0.9) in group 1, as well as a strong direct dependence of PBP on SV (0.8), as well as a direct relationship of SV and PBP (0.9) and reverse SV and DBP (-0.8) (fig. 5). The latter characterizes the tendency to form a hyperdynamic type of hemodynamics. When trying to identify differences in the formation of correlations of cardiac output with other studied parameters of hemodynamics in the first 9 days in comparison with the acute period in the 17-2 group) and 30 days-3 group, significant differences could not be found (tab. 4). Thus, it can be imagined that the formed functional correlations in the first 9 days continue with insignificant changes throughout the entire acute period after SCTBI in children over 7 years old.

Table 4.

Groups	SV/AvBP	SV/PBP	SV/SBP	SV/DBP	SV/HR	SV/T°C
	Dynamics of correlations of the SV circadian rhythm mesor in the first 9 days after SCTBI					
1	-0.8	0.6	-0.5	-0.9	0.0	-0.4
2	0.1	0.8	0.5	-0.3	-0.1	-0.2
3	0.1	0.9	0.4	-0.8	-0.3	0.6
	Dynamics of the SV circadian rhythm mesor in the acute period of SCTBI					
1	-0.8	0.6	-0.5	-0.9	0.0	-0.4
2	0.1	0.7	0.2	-0.5	-0.2	0.5
3	-0.6	0.9	0.0	-0.8	-0.4	0.6

Fig. 7. Comparative assessment of the correlations of the mesor of the circadian rhythm SV in the first 9 days and the acute period of SCTBI in children over 7 years old

Conclusion

Regardless of the severity of injuries with concomitant trauma, a tendency to an increase in the mesor of the circadian rhythm of stroke blood volume per day was revealed in all subjects. The tendency to increase SV was relatively less pronounced in group 1 than in groups 2 and 3. An increase in the amplitude of daily SV fluctuations up to 22 ml in group 2

can be explained by a decrease in stress-protective drug correction before being transferred to a specialized department. Deformation of the phase structure of not only circadian, but also weekly rhythms with a change in amplitude, wavelength, and a shift in the acrophase peak was revealed. A tendency towards the formation of a hyperdynamic type of hemodynamics was revealed.

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TYPES OF OPHTHALMOPATHY IN HYPERTRIGLYCERIDEMIA (CLINICAL OBSERVATION)

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Abstract. Dyslipidemias are the most important factor in the formation and progression of atherosclerosis and associated cardiovascular diseases, hemodynamic changes in the eyes. The article presents the spectrum of ophthalmopathies in the patient Patient D., middle age, consisting in changes in the bulbar conjunctiva, cornea, vitreous body, retinal vessels. Additional clinical and laboratory research revealed an increase in the level of triglycerides in the peripheral blood, cardiovascular changes.

Keywords: dyslipidemia, hypertriglyceridemia, ophthalmopathy, retinopathy

Dyslipidemias are the most important factor in the formation and progression of atherosclerosis and associated cardiovascular diseases (CVD) [4,5]. Currently, significant advances have been made in the diagnosis and treatment of atherosclerosis [6,9,10]. As a result of CVD in Europe, more than 4 million deaths are registered annually (women 2.2 million, men 1.8 million), and mortality is higher among men under the age of 65 (490.000 versus 193.000) [6.9]. In addition, the prevalence of CVD risk factors such as diabetes mellitus and hypertension is increasing [2,8]. At the same time, there is a high frequency of comorbid pathology with a progressive course leading to disability and early mortality [1,4,9]. The above requires the development of early diagnostic methods and effective treatments.

At the present stage, great importance should be paid to the prevention of atherogenic CVD by promoting a healthy lifestyle, combating bad habits, as well as correcting dyslipidemia, normalizing blood pressure (BP), and compensating for diabetes mellitus [3,4,6]. Currently, within the framework of comorbid pathology, mainly in the elderly, there is a high frequency of vascular lesions of the structures of the eyeball and the adnexa of the eye [3,5,7]. Various types of ophthalmopathy, including ischemic neuropathy, are the most important medical and social problem [1,4,11].

The aim of the study is to present a clinical case of observation of ophthalmopathies in a middle-aged patient against the background of an increase in the level of triglycerides in the peripheral blood.

Material and methods

Patient D., 50 years old, applied to an ophthalmologist with complaints of a gradual decrease in distance vision for two years. A year ago, he was examined by an ophthalmologist for a prophylactic examination, who diagnosed mild myopic astigmatism and recommended spectacle correction for distance work. He considers himself healthy, does not take medications. History of cholecystectomy for cyst of the gallbladder 5 years ago. A standard ophthalmological examination was carried out, which included: visometry, tonometry, perimetry, biomicroscopy of the anterior segment of the eye and vitreous body, as well as fundus ophthalmoscopy. Tonometry (measurement of intraocular pressure) was carried out using a non-contact automatic pneumotonometer from Reichert (USA). Perimetry (study of the peripheral boundaries of the visual field, identification of the central and paracentral cattle) was carried out on the perimeter of PNR-2-01 (Russia). Biomicroscopy of the anterior segment of the eye and the vitreous was carried out using a slit lamp "SL-140" from "CarlZeiss Meditec AG" (Germany). Fundus ophthalmoscopy was performed behind a slit lamp under mydriasis conditions using an OcularMaxField 78D non-contact lens. Advanced ophthalmic research methods included: refractometry, keratometry, optical coherence tomography (OCT), ultrasound examination (USE) of the eyeball. Refractometry and keratometry were performed on an automated autokeratorefractometer "HUMPHREY"(Japan). USE of the eyeball - measurement of the depth of the anterior chamber of the eye, the thickness of the lens and the length of the anterior-posterior axis of the eye, the state of the vitreous body was carried out using an Ocuscan R×P ultrasound apparatus from Alcon (USA). Optical coherence tomography using an RTVue-2000 OCT device (Optovue, Inc., Fremont, CA) in the macular region (GCC protocol); retinal vessels autofluorescence was additionally performed.

Results and Discussions

On examination: Visual acuity: Right eye: 0.4 with cyl-0.75 correction D ax 106^0 = 0.8. Left eye: 0.3 sph correction + 0.5 D cyl-0.75 D ax 88^0=0.9. On external examination, OD/OS: orbit, position of eyes, locomotor apparatus is normal. The lacrimal organs were normal. In biomicroscopy, OU - the eyelids were unremarkable. On biomicroscopy of the bulbar conjunctiva (fig. 1), perivascular changes were manifested by perivascular edema. Changes in the shape of the vessels in the form of a decrease in the arteriovenous ratio of more than ¼ and the formation of zones of desolation, while pathological tortuosity of the veins, the formation of a reticular structure, and multiple microaneurysms were revealed. Intravascular changes were expressed in the form of microthrombosis.
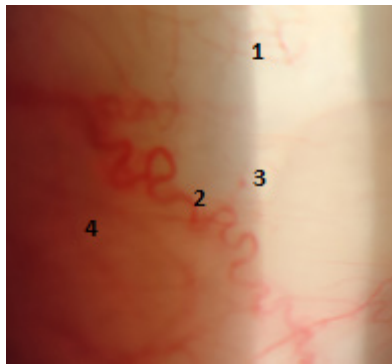
Figure 1. Biomicroscopy of the bulbar conjunctiva of patient D., 50 years old: 1 – desolation zones, 2 – pathological tortuosity of veins, 3 – aneurysms, 4 – mesh structure

Along the limbus there is a concentric ingrowth of the superficial vessels of the conjunctiva in the form of pannus, more pronounced in the upper quadrant (from 10 to 2 o'clock). The cornea is transparent. The anterior chamber is of medium depth, uniform, the moisture of the anterior chamber is transparent. The iris is calm, the pupil is centered, and the response to light is unchanged at 3.5 mm. The fundus reflex is pink. In the vitreous body, retrolental filamentous destruction of the vitreous body. When biomicroscopy with a high-dioptric aspherical lens of 78 diopters, the fundus of the eye: the optic disc of a pale pink color, clear boundaries, the course and ratio of vessels 1:3, Salus-Gunn grade 2, pathological tortuosity of the veins - Gvist on the right eye. No problem areas were found on the retinal periphery.

Fields of view for white color 0.5 cm OD/OS are normal.

IOP (pneumotonometry) OD/OS 13 mmHg / 17 mmHg

Additional research methods.

Ultrasound examination of the eyes (fig. 2.3). Anteroposterior eyeball size 23.0 mm/23.1 mm, anterior chamber depth 3.0 mm/3.0, transparent lens, transverse lens size 4.0 mm/3.9 mm, OD - vitreous body hyperechoic formations in the form of dots and short lines are parietally determined, the volume of the vitreous body is 4 ml, the thickness of the inner membranes is 1.0 mm.

Conclusion – Vitreous destruction (vitreous asteroid), thickening of the choroid in both eyes
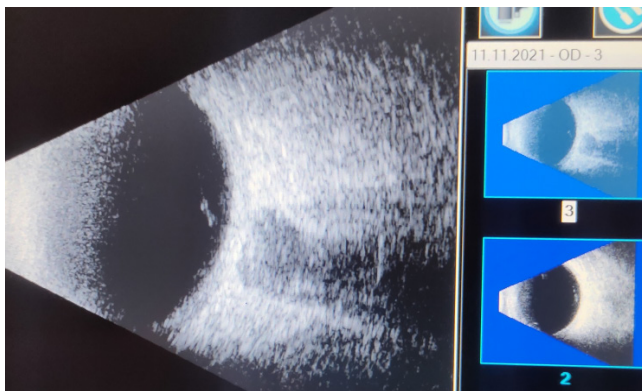
Figure 2. Ultrasonograms of the right eyeball of patient D., 50 years old
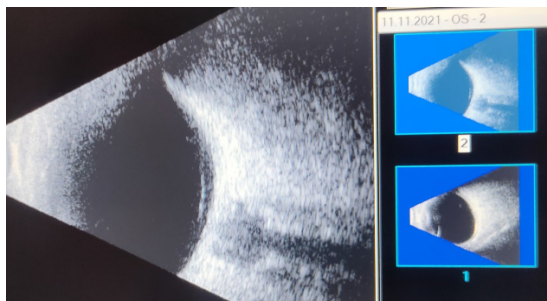
Figure 3. Ultrasonograms of the left eyeball of patient D., 50 years old

Optical coherence tomography of the retina

On a linear section of the retina (fig. 4), no gross morphometric abnormalities were revealed; detachment of the posterior vitreous plate with paramacular fixation (white arrow) of the right eye was determined.
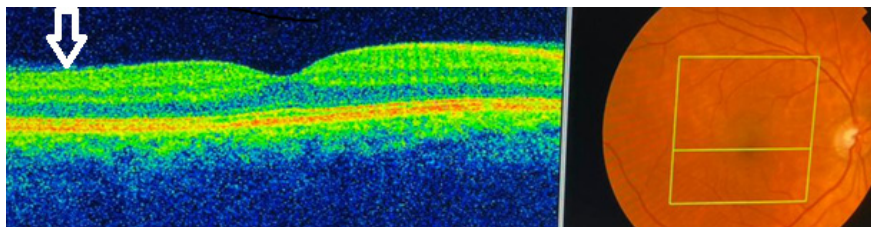
Figure 4. OCT linear section of the macular region of the retina, retinogram of the right eye of patient D., 50 years old

Macular OCT (GCC protocol) revealed thickening of the retinal layers in the fovea, thinning of neuroretinal fibers in the upper paramacular quadrant of the right eye, and changes in autofluorescence in the macular, para, and perimacular regions of both eyes (fig. 5).
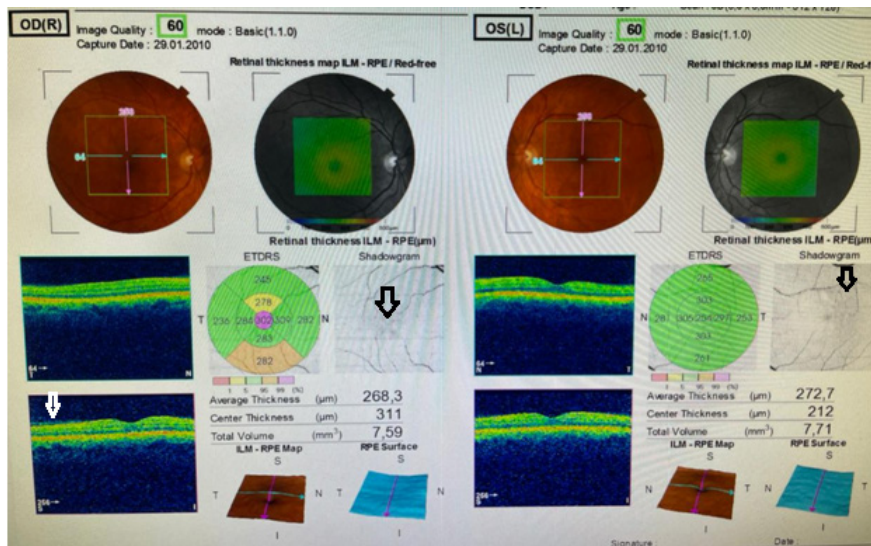
Figure 5. OCT of the macular region (GCC protocol) of patient D., 50 years old

Optical coherence tomography of the retina with autofluorescence (fig. 6,7) identifies hyperfluorescent spots at the posterior pole corresponding to the foci of lipofuscin accumulation in the foveolar, parafoveolar zones (rectangle), tortuosity of the arteries of the macular region of both eyes, proliferation (star) of the right eye.
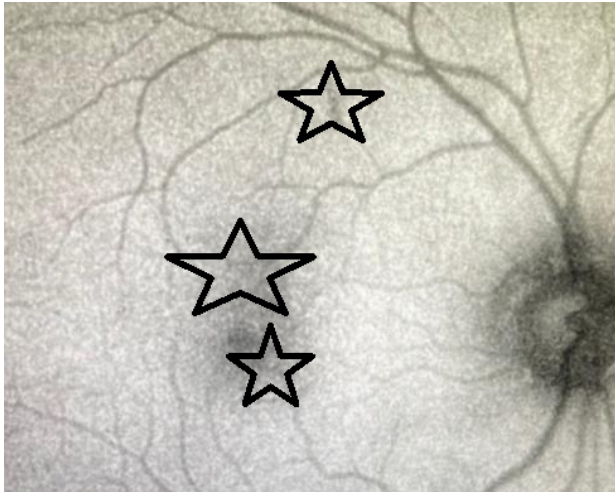
Figure 6. OST data of autofluorescence of the right eye of patient D., 50 years old
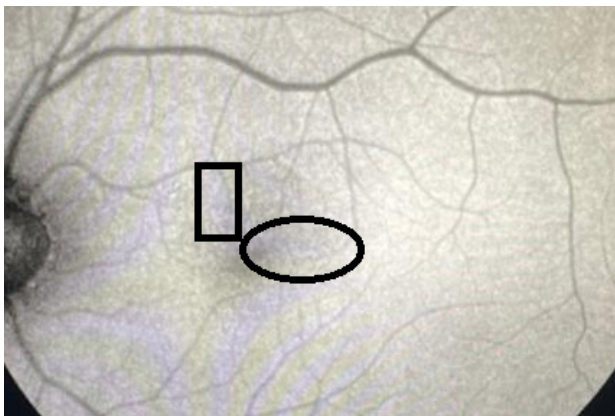
Figure 7. OST data of autofluorescence of the left eye of patient D., 50 years old

According to the examination, changes in the bulbar conjunctiva, vitreous humor, and retinal vessels were diagnosed as follows: Ocular ischemic syndrome (against the background of dyslipidemia?) Manifested by proliferative retinopathy (macular and paramacular regions) of the right eye, hypertensive sclerosis, destruction of the vitreous humor of both (change in the shape of blood vessels and intravascular changes - a sludge phenomenon). Mild mixed astigmatism in both eyes.

Additional examination was carried out on: blood biochemistry, which showed an increase in triglycerides of 3.05 mmol/l (reference value 0-2.3); while cholesterol 5.18 mmol/l, low density lipoproteins 2.92 mmol/l, high density lipoproteins 1.14 mmol/l; blood glucose 5.69 mmol/l, ALT and AST norm. Triplex scanning of the brachiocephalic arteries. The main brachiocephalic vessels are patent. The course of the vessels is straightforward. IMT is heterogeneous. The intima of the internal carotid arteries is compacted, thickened, on the left up to 0.10 cm, on the right up to 0.09 cm. The area of compaction of the flattening of the intima of the internal carotid artery on the left up to 0.13 cm is recorded. The degree of concentric stenosis of the internal carotid artery on the left is up to 11%. Velocity and spectral indicators of blood flow within the age norm. The vertebral arteries are patent. Symmetrical satisfactory blood flow is recorded.

Ultrasound examination of the abdominal cavity and kidneys, complex (Doppler): cholecystectomy; no structural changes were found.

Consultation with a gastroenterologist. Postcholecystectomy syndrome, metabolic syndrome.

Consultation with a physician Arterial hypertension, stage 2, degree 1-2, risk 4. H0(NINA). Dyslipidemia.

Analysis of the nature of the lipid spectrum disorder (according to the results of clinical observation) shows that an increase in triglycerides leads to damage to small arteries (manifestations of ophthalmopathy - vascular lesions of the bulbar conjunctiva, retina, destruction of the vitreous body, corneal changes). In addition, the multifactorial nature of eye damage in dyslipidemia is accompanied by the presence of concomitant diseases, arterial hypertension, metabolic syndrome.

Conclusion

We hope that the analysis of the presented clinical case will arouse not only scientific but also practical interest. Middle-aged patients (45-59) with complaints of a gradual decrease in distance vision that first appeared, it is necessary to examine the lipid profile of peripheral blood and, with an increase in triglyceride levels, undergo an in-depth ophthalmological

examination: OCT of the posterior pole of the eyeball, autofluorescence, USE of the eye. Outpatient ophthalmologists need to carefully examine the hemodynamic state of the bulbar conjunctiva with the study of paravasal and intravascular changes, as well as the shape of the vessels. Therapists, gastroenterologists, with an increase in triglyceride levels, actively refer patients to the examination of the vessels of the carotid zone.

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PSYCHOSOMATIC STATUS OF PATIENTS WITH PERIPHERAL DIABETIC NEUROPATHY

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Abstract. This scientific work analyzed the somatic status and psychological state of 72 patients with peripheral diabetic neuropathy. All of them had a history of panretinal laser coagulation of the retina. The study showed: an increase in AH in varying degrees of severity and CHF in patients with DNR and a decrease in the incidence of obesity, a tendency to an increase in the level of LDL (regardless of DNR), an increased risk of depression in patients with DNR. Unfavorable outcomes of laser coagulation in patients with diabetic nephropathy and diabetic foot syndrome.

Keywords: panretinal laser coagulation, diabetic neuropathy.

Relevance

Diabetic neuropathy (DNR) develops in 80% of patients with diabetes mellitus (DM) duration of more than 10 years, is one of the most common complications of diabetes mellitus and causes disability [1,7]. In patients with DM, the severity of the somatic status affects the microvascular (diabetic nephro- and retinopathy) macrovascular (IHD, cerebrovascular diseases, diseases of the arteries of the lower extremities) manifestations [4,6]. The study of changes in laboratory parameters in patients with micro and microvascular manifestations of the course of the disease is important in terms of diagnosing ophthalmopathies in diabetes mellitus and predict-

ing their course [2,6,7]. DNR is one of the most common complications of diabetes mellitus, in which sensory deficit has a negative impact on the psychosomatic state of patients [5]. In the modern scientific world, the earliest diagnostics and various methods of treatment of diabetic neuropathy are being actively developed [2,7,8].

Purpose of the study

To analyze the somatic status and psychological state of patients with peripheral diabetic neuropathy.

Materials and methods

The study was carried out at SAHCI TO "Multifunctional Clinical and Diagnostic Center" in Tyumen. The object of the study was 72 patients with a history of panretinal laser coagulation of the retina for diabetic retinopathy (DRP) using a solid-state laser VISULAS® 532s from ZEISS. The median age was 65 years, the interquartile range (Q_1; Q_3) was 55-71 years old, the proportion of women was 62.5% (45/72), men 37.5% (27/72). The patients were divided into two groups depending on the presence or absence of such complications as diabetic neuropathy (DNR). Group 1 (n=60) included patients with DNR, and group 2 (n=12) - with no DNR. In group 1, 63.33% of women (38/60), and 36.67% of men (22/60), average age 63.89+5.4; the duration of the disease is 17.4+11.2 years; BMI 31.98+8.2. In group 2, patients are represented by 7 women (58.33%), 8 men (41.67%), average age 59.58 + 8.6; the duration of the disease is 11.75+7.7 years; BMI 32.04 +7.8. All patients were consulted by a general practitioner, endocrinologist, cardiologist. Among the concomitant diseases, a study was carried out for the presence of such pathologies as obesity, arterial hypertension (AH), dyslipidemia and chronic heart failure (CHF). As an additional study, we measured weight, height, daily tonometry, venous blood sampling to study the level of total cholesterol, high and low density lipoproteins, as well as electrocardiography and echocardiography. All participants of the study underwent a standard ophthalmological examination: visometry, tonometry (non-contact automatic pneumotonometer from Reichert), perimetry (PNR-2-01), biomicroscopy of the anterior segment of the eye and vitreous body (slit lamp "SL-140" from "Carl Zeiss Meditec AG"), fundus ophthalmoscopy (using the Ocular MaxField 78D non-contact lens). Analysis of corrected visual acuity in patients was performed before and after laser photocoagulation of the retina. Simultaneously with laser coagulation, a study of the level of depression was carried out using the Beck test questionnaire, sleep quality was assessed using the Pittsburgh questionnaire with further calculation of the sleep quality index (PSQI). Statistical analysis was performed using the statistical packages SPSS for Windows (version

12.0) and STATISTICA (version 7). Continuous variables are presented as M±m (mean±standard error of the mean), regardless of the criterion used.

Results and Discussions

The presence of macroangiopathies such as ischemic heart disease (hereinafter IHD), cerebrovascular diseases (hereinafter CVD) is shown in figure 1. In group 1, IHD was not detected in 27/60 (45%) patients, IHD in its various manifestations was detected in 33/60 (55%) patients. In group 2, IHD occurred only in 3/12 (25%) patients, while IHD was not present in 9/12 (75%) patients. When examining the presence of CVD, the prevalence of these manifestations was revealed in group 1 - 37/60 (61.6%) patients, in group 2 CVD was revealed in 5/12 (41.6%) patients. From these indicators, it should be concluded that in the presence of diabetic neuropathy, the level of macroangiopathy in its various manifestations also increases.
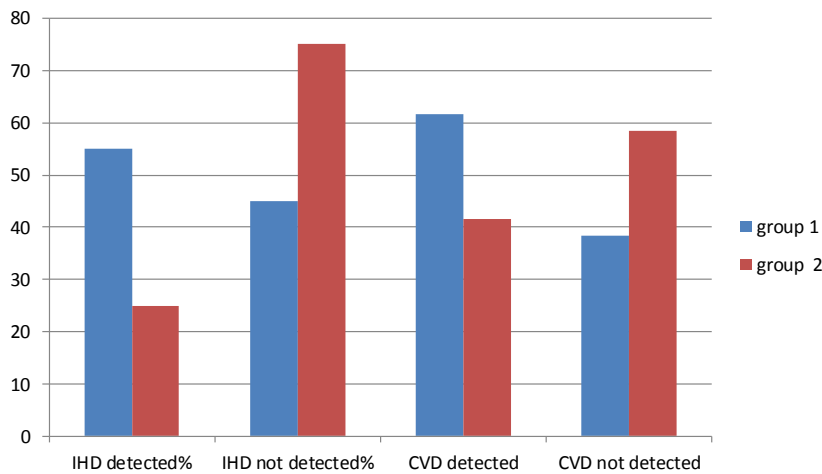
Figure 1. Distribution of macroangiopathy by groups

Obesity was not detected in 17/60 patients (28.33%) of the 1st group and in 2/12 patients (16.67%) of the 2nd group. Body mass index (hereinafter BMI) in group 1 was 33.51+6.49, BMI of group 2 was 32.04+6.92. From which it can be concluded that 71.67% of patients in group 1 suffer from obesity, 83.33% of patients in group 2 (fig. 2).
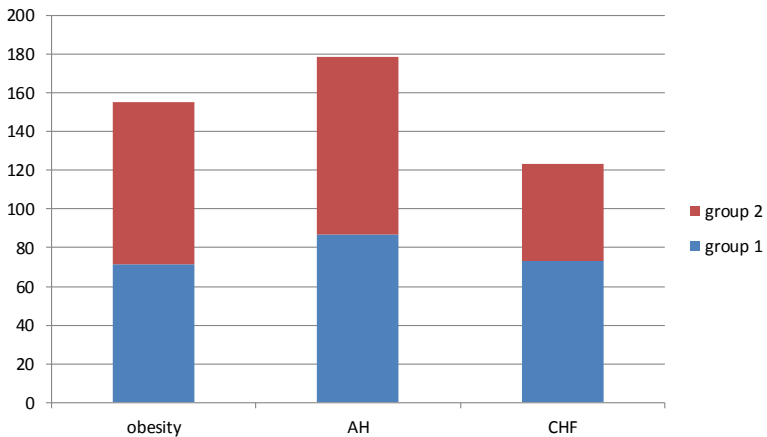
Figure 2 Distribution of comorbidities by groups

AH was detected in 52/60 patients (86.67%) of the 1st group, in 11/12 patients (91.67%) of the 2nd group. However, the severity of AH in patients of group 1, stage 1 AH - 5/60 (8.3%); 2 stages - 27/60 (45%); 3 stages -20/60 (33.4%). In patients of group 2, stage 1 AH - 4/12 (33.3%); 2 stages - 5/12 (41.6%); 3 stages -2/12 (16.7%). Based on these data, it can be seen that the frequency of occurrence of AH in both groups is high, however, this disease is more severe in group 1, where stages 2 and 3 AH prevail, while in group 2 patients, stages 1 and 2 are more common (fig. 3).
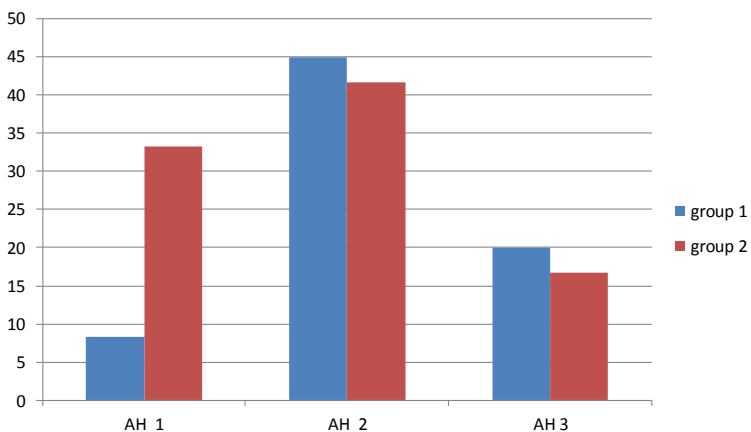
Figure 3 Distribution of AH stage by groups

Chronic heart failure (hereinafter CHF) was detected in group 1 in 44/60 (73.33%) patients; in group 2 in 6/12 (50.0%) patients. Dyslipidemia was detected in all patients in both groups, which was accompanied by an increase in low-density lipoprotein (hereinafter LDL) parameters. The average LDL level in group 1 was 3.85+0.57 mmol/l, (with an optimal/close to normal level of 2.59 - 3.34 mmol/l for patients over 60 years old). In the second group, the average LDL was 3.36+1.05 mmol/l, which is closer to the upper level of the normal indicator. High-density lipoproteins (hereinafter referred to as HDL) in both groups had approximately equal indicators, for the first group the HDL level was 1.45 mmol/l+0.38, for the second group 1.49 mmol/l+0.27, which corresponds to normal values: 0.96-2.36 mmol/l. Based on these data, it should be concluded that in patients with diabetes mellitus, there is a tendency to an increase in the level of LDL, regardless of the presence or absence of diabetic neuropathy.

In group 1, visual acuity with correction before laser photocoagulation averaged 0.41+0.21, after coagulation 0.69+2.65. In group 2, visual acuity with correction before photocoagulation 0.61+0.91, after 0.64+0.06. A detailed analysis of the functional outcomes of laser photocoagulation revealed that visual acuity in patients of group 1 in the postoperative period depended on the presence or absence of concomitant micro- and macroangiopathies, such as diabetic nephropathy and diabetic foot syndrome.

In 5/60 (8.33%) patients, of which women 1/60 (1.6%), men 4/60 (6.7%), average age 54.8+5.4 years; the duration of the disease is 11.6+4.3 years; BMI 37.61+2.9 with no nephropathy of diabetic genesis, with a history of diabetic foot syndrome and manifestations of neuropathy: among concomitant diseases IHD - 2/5 (40%); AH 1 - 1/5 (20%), AH 2 - 2/5 (40%); AH 3-2 / 5 (40%) patient; CVD - 1/5 (20%) patient; CHF - 3/5 (60%) patient. In this group, the visual acuity before laser coagulation of the retina was 0.78+0.1, after 0.9+0.05, which corresponds to a fairly high visual acuity for patients suffering from diabetic retinopathy in varying degrees of its manifestation.

In 31/60 patients (51.67%), of which 22/60 women (36.67%), 9/60 men (15.0%), average age 58.42+7.8; the duration of the disease 17.42+4.3 years; BMI 31.22+4.6 (group 1 b) revealed chronic kidney disease in various stages of manifestation (there were no clinical manifestations of diabetic foot syndrome, but there were manifestations of nephro- and neuropathy of diabetic genesis), of which 1-2 stages in 24/31 patients (77.41%), stage 3 A - 7/31 patients (22.58%). In the study, the visual acuity before laser coagulation of the retina averaged 0.67+0.05, after the procedure 0.70+0.03. Thus, metabolic disorders associated with CKD, damage to

peripheral nerve fibers are combined with damage to the macular region of the organ of vision, which is accompanied by lower indicators of visual acuity both before and after laser coagulation of the retina. In addition, our study showed that the presence or absence of impaired peripheral circulation (diabetic foot syndrome) does not affect the visual prognosis in the postoperative period.

According to the calculated Beck depression scale, patients of group 1 were found to have a mild level of depression. As a result of scoring according to Beck's test questionnaire in this group, the average value was 10.2 ± 2.5. In group 2 with the absence of neuropathy, depression was not revealed; according to the Beck test-questionnaire, the average number of points in this group was 7.8 ± 1.2, which corresponds to normal values.

According to the Pittsburgh questionnaire, patients in group 1 had poor sleep quality of $6.41+0.75$ points.

In group 1 patients with no diabetic nephropathy, according to the results of the Pittsburgh questionnaire, the average score was 4.2 ± 0.5 points, which indicates a good quality of sleep. Thus, the presence of chronic kidney disease in the initial stages of its manifestation or its absence does not affect the increase in the sleep quality index. In patients without clinical manifestations of diabetic foot syndrome, but with manifestations of nephro- and neuropathy of diabetic genesis, the average score according to the results of the Pittsburgh questionnaire was 3.78 ± 0.4 points, which is characteristic of good quality sleep. The results of our study allow us to conclude that the absence of clinical symptoms of diabetic foot also has a beneficial effect on the quality of patients' sleep. Patients of group 1 with CKD 3 A and 3 B, neuropathy and diabetic foot syndrome have a low quality of patients' sleep, the average score was 7.05 ± 0.11 points. More severe forms of CKD in combination with micro and macroangiopathies lead to impaired sleep quality in patients. In group 2, no sleep disturbance was noted; according to the results of the Pittsburgh questionnaire, the average score was 4.95 ± 0.3.

Conclusion

Our study revealed an increase in the level of macroangiopathy, in its various manifestations, in the presence of DNR. Among the comorbidities, an increase in AH of varying severity and CHF was found in patients with DNR and a decrease in the incidence of obesity. Patients with diabetes mellitus, regardless of DNR, tend to increase the level of LDL. The functional outcomes of laser photocoagulation depend on the presence or absence of concomitant micro- and macroangiapathies, such as diabetic nephropathy and diabetic foot syndrome.

As a result of our study and the data obtained, it can be concluded that the presence of DNR increases the risk of depression in patients and, subsequently, the formation of poor quality sleep. In the presence of CKD, especially in advanced stages, there is a tendency to a decrease in visual acuity both before and after laser coagulation of the retina, which in turn also negatively affects the quality of patients' sleep.

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DIABETIC RETINOPATHY FROM THE POSITION OF AN OPHTHALMIC SURGEON

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Abstract. The article defines the features of endovitreal surgery in patients with diabetic retinopathy in a round-the-clock hospital operating in the mode of providing emergency ophthalmic care. The reason for hospitalization in 83% of cases is hemophthalmus, in 17% - retinal vein thrombosis. The profile of patients with diabetes mellitus during the Covid-19 pandemic has been identified: emergency admission with sudden loss of vision; the predominance of patients with type 1 DM insulin-dependent; duration of DM 16 years or more; ill at puberty; - having hyperglycemia uncompensated by endocrinologists.

Keywords: diabetes mellitus, Covid-19, diabetic retinopathy

Relevance

Diabetic retinopathy (DR) is one of the most important medical, social and economic problems of modern healthcare [1,7,8]. Loss of vision as a result of its development and progression remains a serious problem, despite the improvement of methods of glycemic control, the success of laser and vitreoretinal surgery (VRS) [1,7]. To date, there is no doubt about the pathogenetic orientation and effectiveness of VRS in the treatment of advanced proliferative DR [1,2]. Patients with diabetes mellitus (DM)

are at high risk of infection, severe and difficult to treat COVID-19 [7,3,4]. At the present stage, there is an accumulation of practical and scientific knowledge in this area [5,6,9]. The course of a new coronavirus infection in this category of patients is complicated by the decompensation of chronic diseases and the progression of complications [8,10,11]. It is generally accepted that uncompensated hyperglycemia and disease duration are the most important predictors of the risk of diabetic complications [1,7]. The study of the peculiarities of the course of ophthalmic pathology in co-morbidity (DM) against the background of a new coronavirus infection is necessary to optimize diagnostic methods, the treatment of this complex category of patients is of scientific and practical importance.

Purpose

To determine the features of endovitreal surgery in patients with DR in a round-the-clock hospital operating in the mode of providing ophthalmic emergency care.

Materials and methods

The analysis of medical records of inpatients of the ophthalmological department of the State Budgetary Healthcare Institution of the Tyumen Oblast, Oblast Clinical Hospital №2 (SBHCI TO OCH №2) with a history of DM for the period from 2019 to 2021, who received the following types of surgical treatment: anti-VEGF drugs, vitreoectomy, laser coagulation (LC), endovitreal tamponade with air or silicone.

Results and discussion

The dynamics of hospitalized patients with DM, presented in Figure 1, showed a decrease in hospital admissions in 2020 compared to 2019, which is associated with the epidemiological situation for the new coronavirus infection. There was an increase in hospitalizations in 2021: 15 patients in 6 months, while in 2020 - 10 patients. Attention is drawn to the prevalence of women - 53.2% (25 people) than men - 29.8% (14 people), who have complicated forms of the disease requiring endovitreal intervention (fig. 2)
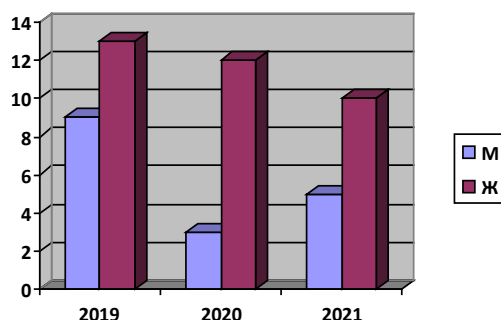
Figure 1. Dynamics of hospitalization in the ophthalmology department SBHCI TO OCH №2 of patients with DM for 2.5 years

Insulin-dependent DM was present in 53.2% of patients, insulin-independent - in 46.8% of patients. The median duration of the disease was 19 years (16-23). In 66.7% of patients, renal dysfunction - chronic kidney disease (CKD) - was revealed. 16% of patients have no signs of CKD (according to creatinine, urea, urinalysis). It is noteworthy that in these patients DM appeared in adolescence, hyperglycemia on admission above 20 mmol/l, the duration of the disease for more than 20 years. The presence of grade 3 arterial hypertension (AH) was diagnosed in 50% of patients, grade 2 AH in 16.6%. Thus, most patients have CKD and AH (markers of proliferative traction). A history of panretinal LC of the retina was performed in 83.3% of cases.
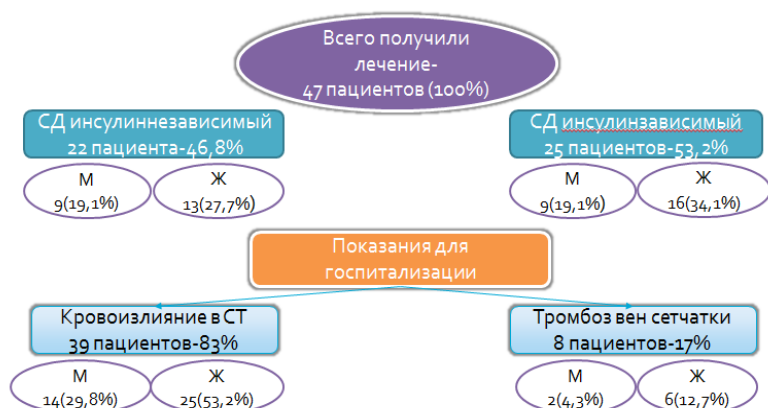
Figure 2. Structure of DM types and DR complications

The morphological features of the retina revealed during the operation showed the presence of gliosis in 100% and every third had traction retinal detachment in one eye (fig. 3). Vitrectomy was completed with endovitreal tampanade with air or silicone at the same frequency.

Figure 3. Morphological features of the retina and types of endovitreal tamponade in patients with hemophthalmos

The study made it possible to **identify the profile of patients** with DM in an ophthalmological hospital operating around the clock to provide emergency ophthalmic care during the Covid-19 pandemic: emergency admission with sudden loss of vision; the predominance of patients with type 1 DM insulin-dependent; - DM duration of 16 years or more; ill at puberty; - having hyperglycemia uncompensated by endocrinologists.

Clinical case №1

The patient – a man, 31 years old. I went to the SBHCI TO OCH №2 admission department with complaints of a veil, decreased vision in the right eye. On urgent indications, he was hospitalized in the ophthalmological department. She notes an increase in blood pressure for a long time with maximum figures up to 190/110 mmHg, independently and regularly takes antihypertensive therapy. He has type 1 DM for 23 years, insulin therapy (humalog, levemir), constantly monitors glycemia.

Local status upon admission: St. Oculorum VOD = 0.06 n/c, VOS = 0.6

s/c -1.5 = 1.0.

External examination OD/OS: orbit, eye position, normal motor apparatus. When biomicroscopy OD/OS: eyelids, conjunctiva and lacrimal organs without features. The anterior chamber is of medium depth, uniform. The iris was normal, the pupil was round, uniform, OD - 3.5 mm, the direct reaction of the pupil to light was sluggish, the friendly reaction was normal. OS – the pupil's direct and friendly reaction to light is normal. The lens is transparent.

When biomicroscopy with a high-diopter aspherical lens 78 diopters: OD - fundus reflex is weak. The fundus of the eye is visible in areas, in the vitreous body there are multiple floating opacities "hemo". A pale pink optic nerve disc (OND) is visualized behind the thick fleur, the boundaries are clear, the arteries are moderately narrowed, the veins are dilated, traces of laser coagulates are visible on the middle periphery. The outer and inner segments of the fundus are not visible, in the lower segment under the "thick fleur" a conglomerate of proliferative tissue is visualized, fixed with the retina.

When biomicroscopy with a high-dioptric aspherical lens of 78 diopters, the fundus of the OS: OND is pale pink, the boundaries are clear, the arteries are moderately narrowed, the veins are dilated. The reflex of the macular area is clear. Salus II, multiple microaneurysms, solid exudates. Traces of laser coagulates on the periphery are visible.

Blood glucose on admission: 18.4 mmol/l.

Diagnosed with: Primary: Partial hemophthalmus of the right eye. Proliferative diabetic retinopathy, a condition after panretinal LCS in both eyes. Concomitant diseases: DM type 1. Diabetic microangiopathies: nephropathy, CKD C2. Target level of glycemic control: HbA1c <7.0%, fasting/premeal plasma glucose <7.0 mmol/l plasma glucose 2 hours after meals <9.0 mmol/l. AH grade 3, stage 1, risk 4.

Conservative and surgical treatment was carried out:

1) intravitreal injection of drugs (Eylea) into the right eye; 2) after 4 days: vitreosvartectomy of the right eye, endolaser coagulation.

Local discharge status: St. Oculorum VOD = s/d 0.6-0.7 n/c, VOS = 0.6 s/c -1.5 = 1.0.

When biomicroscopy with a high-diopter aspherical lens 78 diopters fundus OD: fundus reflex pink. Avitria. The fundus of the eye: OND pale pink, clear boundaries, the arteries are moderately narrowed, the veins are dilated, twisted, single hemorrhages along the vessels, single newly formed vessels. All over the fundus there are traces of pigmented laser coagulates, the retina is attached in all parts.

When biomicroscopy with a high-dioptric aspherical lens of 78 diopters, the fundus of the eye OS: no dynamics. Treatment result: improvement.

Conclusion

At the moment, the ophthalmologist's arsenal includes conservative, surgical and combined DR treatment methods that affect various links in the pathogenesis of the disease. Given the fact that in the context of the Covid-19 pandemic, many patients with DM are in self-isolation mode and the availability of face-to-face advice from endocrinologists and ophthalmologists has decreased, patients began to seek emergency medical care with complicated forms of DR that require vitreoretinal surgery. Complicated forms of diabetic retinopathy are observed more often in women than in men. The reason for hospitalization in 83% of cases is hemophthalmus, in 17% - retinal vein thrombosis. The prevalence of patients with type 1 DM, insulin-dependent, with a disease duration of 19 years or more, ill at puberty, with hyperglycemia, uncompensated by endocrinologists. Most patients have CKD and AH (which are markers of proliferative traction). Effective treatment of diabetic retinopathy is possible only with compensation of clinical and laboratory parameters and a multidisciplinary approach.

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THE TACTICS OF PRESCRIBING GLUCOCORTICOIDS SYSTEMICALLY IN PATIENTS WITH RHEUMATIC DISEASES

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Abstract. We retrospectively analyzed the medical records of 200 patients suffering from rheumatic diseases: of them with rheumatoid arthritis (100 people), systemic lupus erythematosus (SLE) (50 people), systemic scleroderma (SSD) (50 people). All underwent a comprehensive study by a rheumatologist and an ophthalmologist, which showed the need for systemic glucocorticoids in patients with diffuse subfoveolar choroid thickening> 350 μm and morphostructural disorders - an increase in blood vessels (large - Haller's layer and medium - Sutler's layer), the presence of fibrotic changes in the vitreous to achieve induction-remission.

Keywords: rheumatic diseases, choroid, optical coherence tomography.

Relevance

Rheumatic diseases are systemic and have extra-articular manifestations, including ophthalmic ones [1, 4, 9]. There are various points of contact between ophthalmologists and rheumatologists. On the one hand, when there are inflammatory changes in the eye, the ophthalmologist is faced with the question of whether the cause is systemic inflammatory rheumatic disease; on the other hand, a rheumatologist must remember that there are ophthalmological manifestations of these diseases, and if they are present, this greatly affects the stage of the underlying disease, treatment tactics and prognosis [2, 3, 4, 8]. Ophthalmopathies can develop in many systemic autoimmune rheumatic diseases. Lack of treatment,

which can lead to severe irreversible loss of vision [5, 6, 7]. In 2013, for the first time in the world, the term "pachychoroidal states" was introduced - a thickening of the choroid, which is a biological marker of autoimmune inflammation in the body [1, 10]. Ophthalmic manifestations can serve as a biomarker of the onset or exacerbation of many rheumatic diseases [2, 4]. In addition, studies of ophthalmopathies can expand the diagnostic capabilities of the underlying rheumatic disease [1, 3].

Purpose of the study

To determine the appropriateness of systemic glucocorticoid administration in patients with rheumatic diseases based on the results of additional research methods (optical coherence tomography) of the eyeball.

Materials and methods

Standard (visometry, tonometry, biomicroscopy, ophthalmoscopy, refractometry, keratometry) and in-depth ophthalmological research methods (including ultrasound of the eyeball, optical coherence tomography (RTVue-2000 OST device) with obtaining a linear scan of the retina of the macular region in the horizontal plane) arthritis (100 people), systemic lupus erythematosus (SLE) (50 people), systemic scleroderma (SSD) (50 people) with a parallel examination by a rheumatologist in accordance with the protocols of the Federal Clinical Guidelines with the determination of the activity of the process on the basis of the Rheumatological Center in Tyumen, the rheumatology department SBHCI TO "OCH № 1". At the time of examination, the patients did not show active complaints from the organ of vision.

Results and Discussions

In the course of the study, the patterns of diffuse thickening of the choroid subfoveolar> 350 μm were determined with a change in the morphostructure (an increase in the vessels of the Haller and Sutler layers) and the presence of fibrous changes in the vitreous body in patients with rheumatic diseases. In addition, all examined patients had clinical manifestations of dry eye syndrome (the presence of specific and indirect signs). According to Schirmer's test, the pathology of total tear production was detected in 94.1% of patients, of which moderate (8.0$\pm$2.0 mm) - in 11.8% of patients, severe (2.5$\pm$2.0 mm) - in 82.3%. Microcystosis of the conjunctiva in the projection of the palpebral fissure was diagnosed in 40.6% of patients, pinguecula - in 44.7%. Refractive errors were identified in 88.2%. In the structure of refractive errors, the first place is taken by myopia (76.4%), the second - by hyperopia (16.8%), the third - by astigmatism (6.8%). High myopia was diagnosed only in patients with SSD with a diffuse form of the disease of a chronic course and the presence of concomitant cardiovas-

cular diseases (AH in all cases of observation, IHD in one case). In this publication, we want to demonstrate an illustrative clinical case. A man born in 1965 with a diagnosis of "Seronegative rheumatoid arthritis, late stage, high activity, X-ray stage 2b, FC III" is observed in the rheumatology department SBHCI TO "OCH № 1" of the city of Tyumen. According to the patient, he considers himself ill for 10 years, when pain in the ankle joints first appeared, with periodic exacerbations up to 3-5 times during the year. Was observed by a therapist at the place of residence, took non-steroidal anti-inflammatory drugs (NSAIDs) irregularly for acute pain syndrome. In July 2014, after an additional examination in the rheumatology department, the diagnosis was made "Rheumatoid arthritis, seronegative variant, late stage, high activity, X-ray stage 2b, FC III", methotrexate at a dose of 15 mg per week and situational NSAIDs were prescribed as the basic drug. I did not take the recommended drugs all the time. On 16.09.2016, there was a deterioration in health, which was manifested by severe pain, stiffness in large and small joints, and therefore, he turned to the clinic at his place of residence, followed by hospitalization. From 23.09.2016 was in the rheumatology department. Upon admission, he was referred to an ophthalmologist for an in-depth ophthalmological examination, including optical coherence tomography (RTVue-2000 OST device) with obtaining a linear scan of optical coherence tomography of the retina of the macular region in the horizontal plane through the central fossa. The ophthalmologist revealed a diffuse thickening of the choroid subfoveolar OD382 μm/ OS 364 μm (fig. 1), a violation of the morphostructure - an increase in blood vessels (large - Haller's layer and medium - Sutler's layer) and the presence of parietal fibrous changes in the vitreous (local epiretinal region, fibrosis of the macular detachment of the posterior vitreous plate with paramacular fixation, parietal punctate fibrous changes in both eyes).

After an examination by an ophthalmologist to reduce the activity of the disease, methotrexate 15 mg intramuscularly was added to the drug, methylprednisolone 250 mg intravenously was added. On 18.10.2016, he was discharged from the department with a positive effect (notes a decrease in pain and stiffness in the joints, a decrease in indicators of the acute phase of inflammation is recorded). Given the positive effect of basic drugs (methotrexate and methylprednisolone) after discharge, drug therapy is recommended, including: methylprednisolone 4 mg at 7.00 - 2 tablets after meals and methotrexate 12.5 mg i/m 1 time per week, NSAIDs - situationally for joint pain and spine. The given clinical example clearly demonstrates that in a patient suffering from Rheumatoid arthritis, with a diffuse thickening of the choroid subfoveolar >350 μm (OD 382 μm/OS

364 μm), a violation of its morphostructure - an increase in blood vessels (large - Haller's layer and medium - Sutler's layer) and the presence of parietal fibrous changes in the vitreous body (local epiretinal fibrosis of the macular region, detachment of the posterior vitreous plate with paramacular fixation, parietal punctate fibrotic changes), the administration of glucocorticoids systemically as part of basic therapy leads to a positive result in treatment - a decrease in pain syndrome.
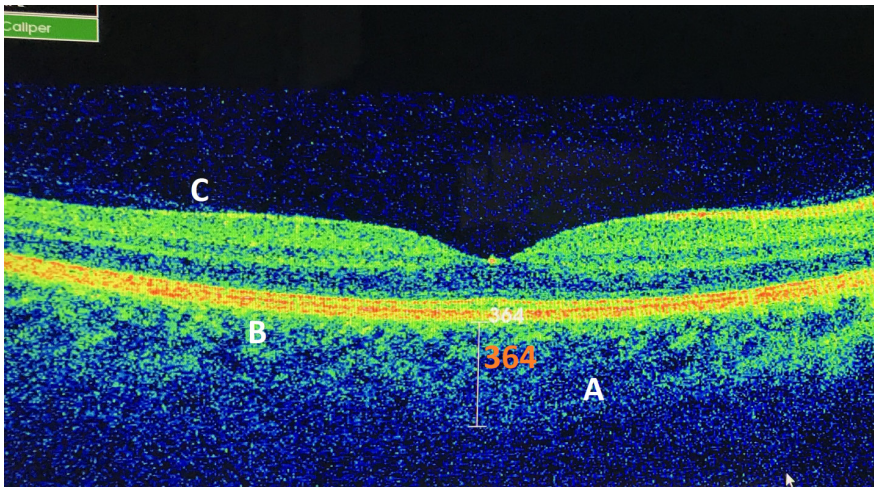
Figure 1. Linear scan of optical coherence tomography of the retina of the macular region in the horizontal plane through the central fossa (RTVue-2000 OST device) of a patient suffering from rheumatic disease (A – an increase in the vessels of the Haller layer; B – an increase in the vessels of the Sattler layer; C – parietal fibrous changes in the vitreous body; 364 - the thickness of the choroid is subfoveolar)

Conclusion

This publication demonstrates a method for diagnosing the need to prescribe glucocorticoids systemically to patients with rheumatic disease, which has sufficient grounds for clinical use in practical health care, widespread implementation in algorithms for preventive examinations. An important feature is the possibility of early diagnosis of ophthalmic changes at the preclinical stage, when patients do not yet present eye complaints. This will help in the future to develop methods of drug correction of oph-

thalmopathies in rheumatic diseases against the background of adequate basic therapy with glucocorticoids. Glucocorticoid drugs allow the drug to penetrate through the blood-brain barrier, which reduces the risk of developing eye pathology against the background of rheumatic diseases.

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OCT ANGIOGRAPHY IN PATIENTS WITH DYSLIPIDEMIA WHO HAVE HAD COVID-19 ASSOCIATED PNEUMONIA

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Abstract. The article presents the results of a pilot study studying the features of the vitreoretinal interface in patients with dyslipidemia who underwent COVID-19 associated pneumonia depending on age, which showed a relationship with the presence of somatic polymorbidity - arterial hypertension, type 2 diabetes mellitus, metabolic syndrome, dyslipidemia and refractive-myopia anomalies.

Keywords: dyslipidemia, OCT angiography, COVID-19 associated pneumonia

Relevance

Modern scientific works 2020-2021, devoted to the study of the manifestations of a new coronavirus infection, indicate a deterioration in the parameters of arterial regional blood flow in patients who have undergone COVID-19 associated pneumonia [2,3]. Disturbance of regional blood circulation (microcirculation of the bulbar conjunctiva) occurs as a result of endothelial dysfunction (ED), with increased thrombus formation, adhesion of leukocytes to the endothelium and vasospasm [1,5,6]. The vascular endothelium, from the standpoint of modern science, is a giant paracrine organ capable of producing a large amount of the most important biologically active substances (vasodilators, antiplatelet agents, vasoconstrictors, pro-

aggregants, heparin, plasminogen activators, growth factors, etc.) [1,4,5]. From our point of view, during the period of accumulation of knowledge about changes in the human body against the background of coronavirus infection and the early recovery period, it is advisable to conduct vascular studies using available imaging methods - optical coherence tomography (OCT).

The purpose - is to conduct a pilot study to study the features of the vitreoretinal interface in patients with dyslipidemia who have undergone COVID-19 associated pneumonia, depending on age.

Materials and methods

40 patients (80 eyes) with a documented diagnosis of COVID-19-associated pneumonia were prospectively examined 3 months after discharge from the hospital, who gave informed consent to participate in the study. The study included 20 men, median age 38 (18-62) years, 20 women, median age 50 years (20-64). The classification of ages adopted by the WHO was used: young people (18-44), middle age (45-59), old age (60-74). Young people made up 15% (6/40); middle age 50% (20/40); elderly 35% (14/40).   *Inclusion criteria:* patients who were hospitalized with a documented diagnosis of COVID-19-associated pneumonia; both sexes, over the age of 18; who gave written informed consent to participate in the study. *Exclusion criteria:* trauma to the organ of vision; a history of chronic inflammation of the choroid, retina and optic nerve, not associated with COVID-19; hereditary pathology of the organ of vision (retina and MN). A comprehensive examination of patients was carried out: therapist, cardiologist, doctor of functional diagnostics. Ophthalmological examination included standard research methods: visometry, autorefractometry, tonometry, static and kinetic perimetry, biomicroscopy, direct and reverse ophthalmoscopy under conditions of drug mydriasis, fundus examination using an aspherical high-dioptric lens 90D. Optical Coherence Tomography - Angiography (Canon OCT-HS100, Software: RX Capture for OCT-HS100 ver.4 (Version 4.4.1.9)). Statistical processing of the obtained material was carried out in the Statistika program (version 6).

Results and discussions

The analysis of the age category showed the predominance of middle-aged and elderly people, which corresponds to the average incidence rates of new coronavirus infection [1,2]. The structure of comorbidity in the study group revealed the presence of dyslipidemia in 90% (36/40) patients, atrerial hypertension (AH) in 87.5% (35/40) patients; metabolic syndrome and diabetes mellitus with the same frequency of occurrence in 16.7% (10/40) of patients. The results of the study of clinical refraction revealed

emmetropia in 5% of cases, hyperopia and myopia in 47.5% of cases. Comparative evaluation of optical coherence tomography data revealed certain features of changes in data depending on age (fig. 1, 2, 3).
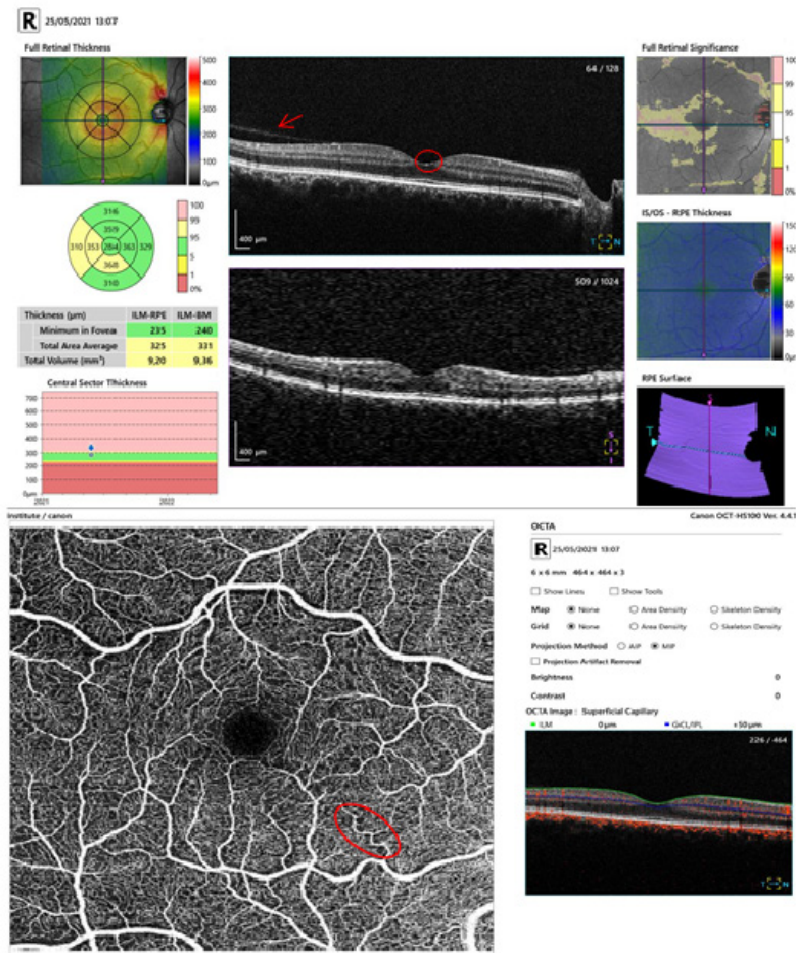
Figure 1. Structural OCT and OCT-angiography of the superficial capillary plexus: incomplete detachment of the posterior vitreous plate (red arrow); focal fibrosis of the macular region (red circle); corkscrew tortuosity of small venules, Gvist's symptom (red oval)

Figure 2. structural OCT and OCT-angiography of the superficial capillary plexus: incomplete detachment of the posterior vitreous plate (red up arrow); focal fibrosis of the macular region (red down arrow); corkscrew tortuosity of small venules, Gvist's symptom (red oval)
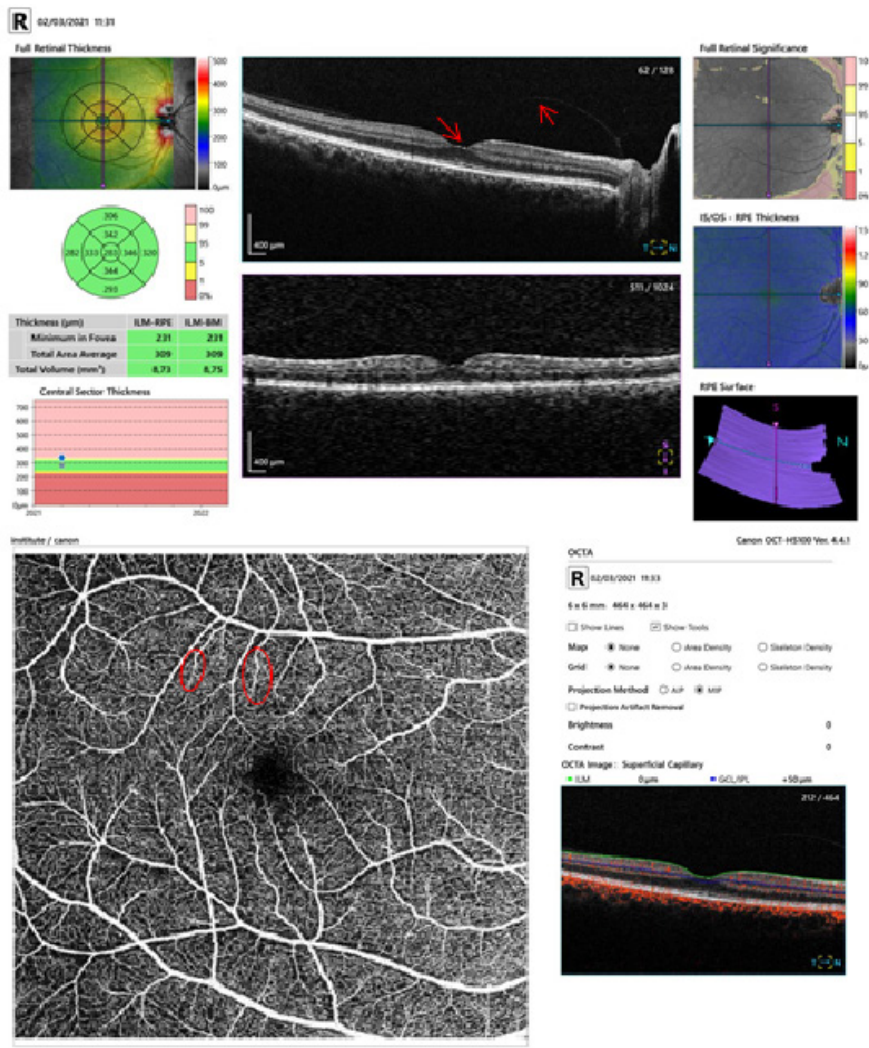
The results of OCT analysis and OCT-angiography in young patients 18-44 revealed the following features: 66.7% (4/6) incomplete detachment of the posterior vitreous plate; 83.3% (5/6) focal fibrosis of the macular region; 33.3% (2/6) corkscrew tortuosity of small venules, a symptom of Gvist, which was detected in patients with overweight and obesity.

The results of OCT and OCT-angiography **analysis in middle-aged patients revealed the following features: 85% (**17/20) - incomplete detachment of the posterior vitreous plate; 90% (18/20) - focal fibrosis of the macular area; 45% (9/20) - corkscrew tortuosity of small venules, a symptom of Gvist (red oval), revealed in overweight and obesity. High detachment of the posterior vitreous plate with macular fixation (fig. 2, red upward arrow), focal fibrosis of the macular region was detected in a patient with overweight, AH, dyslipidemia (total cholesterol 6.4 mmol/l; low density lipoprotein (LDL)) -4.2 mmol/l; Triglycerides (T) - 2.9 mmol/l).
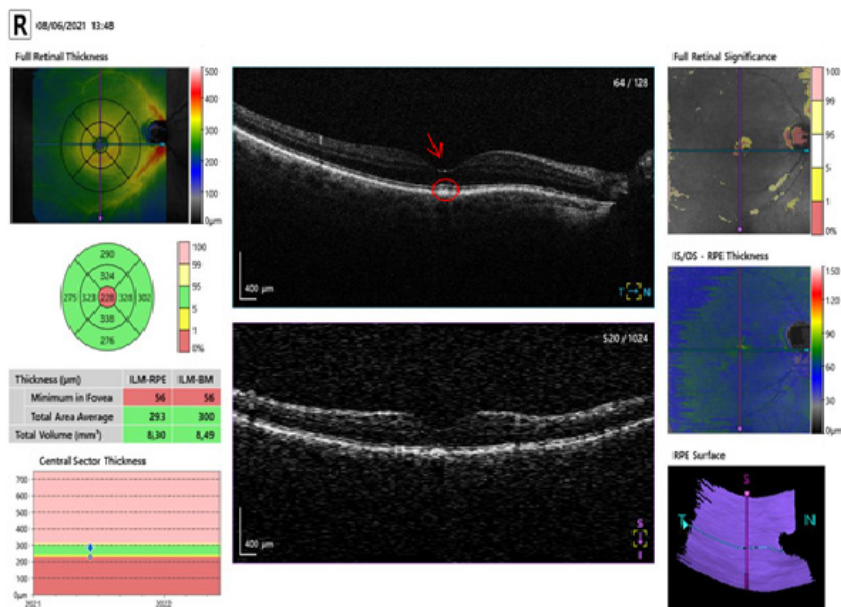
Figure 3. Structural OCT, undulating deformation of the pigment epithelium (red arrow)

The results of OCT analysis and OCT-angiography in elderly patients 60-74 revealed the following features: 64.3% (9/14) - incomplete detach-

ment of the posterior vitreous plate; 85.7 (12/14) - focal fibrosis of the macular region; 21.4% (3/14) - corkscrew tortuosity of small venules, Gvist's symptom; 28.6% (4/14) - undulating deformation of the pigment epithelium. With wave-like deformation of the pigment epithelium in patients, it was noted: duration of AH 22.9$\pm$6.2 years, obesity of 2-3 degrees, dyslipidemia of varying severity, myopia.

Conclusion

Features of the vitreoretinal interface in patients with dyslipidemia who have undergone COVID-19 associated pneumonia are associated with the presence of somatic polymorbidity - arterial hypertension, type 2 diabetes mellitus, metabolic syndrome, dyslipidemia and the presence of ophthalmic polymorbidity (refractive error-myopia).

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THE IMPORTANCE OF ORGANIZING AND CONDUCTING FUNCTIONAL OPTICAL-REFLEX TRAINING IN PREVENTING THE PROGRESSION OF MYOPIA IN CHILDREN IN THE REGION

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Abstract. Based on the results of a preventive examination of children - residents of the city of Tyumen, aged from 7 to 18 years, in the period 2011-2018 with an identified pathology of the organ of vision, courses of functional optic-reflex training of accommodation were organized and conducted. The medical efficiency of the three-year treatment of patients with diagnoses of "Myopia" and "Disorders of accommodation" for updating the tactics of managing patients at the territorial level and the possibility of stabilizing the state to control myopia was evaluated.

Keywords: preventive examinations, children's school age, myopia, accommodation disorder, functional optic-reflex training.

Relevance

Myopia (nearsightedness) is a significant medical and social problem of modern society. Its prevalence in developed countries is 19-42% in the population [1,6], reaching 70% in some countries of the East [9]. The conditions of increasing teaching loads, technological equipment in schools, unlimited enthusiasm for gadgets, and in some cases hereditary predisposition lead to visual impairment in children. When entering school, even

a healthy child needs to adapt to completing school assignments, norms and rules of behavior. In myopia, there is a negative value of visual work at close range, and this view is confirmed by the significantly increased frequency of myopia in Asia over the past 20 years due to the intensity of training and the massive use of information technologies [9]. In Russia, following the results of clinical examination, the incidence of myopia in children and adolescents over the past 10 years has increased by 1.5 times. With an increase in school experience, the frequency of myopia increases: in the primary grades it ranges from 6-9% and 25.0-32.2% is detected among school graduates [3]. Myopia occurs more often in students of urban schools, gymnasiums and lyceums (up to 50%), due to the specialization of education, less exposure to the fresh air and physical inactivity [1,3,6]. The increase in the number of eyes with myopic refraction for an academic year in a secondary school is 1.5-5.3%, mainly due to pupils of junior and middle grades, in a lyceum 13-14% [3,4,5]. With the frequency of myopia, its degree also increases, reaching 6.0 Dptr and more in 10-12% [1]. In Tyumen Oblast over the past 15 years, according to preventive examinations of the child population, refraction pathology prevails among the reasons for decreased vision, and myopia is diagnosed in 53.1% of cases, accommodation disorders in 9.0%. The rate of progression of myopia is on average 0.4 Dopt per year, in the senior grades the growth slows down somewhat - 0.3 Dopr per year [2]. Patients with accommodation pathology are at risk for the development of myopia [1]. Accommodation disorders: weakness, lagging of the accommodative response, excessive pathological tone - primarily precede the onset and accompany the development of myopia [4,5]. Among the indicators of the function of the ciliary (accommodation) muscle, the most important is the positive part or the positive relative accommodation (PRA), because a decrease in it causes an aggravation of the process and is a criterion for the threatening progression of myopia. Knowledge of this indicator is necessary when carrying out measures related to the prevention of the onset and progression of myopia [4, 5, 8], since during visually strenuous work, first of all, the growing organism suffers from accommodation, which is in constant stress [4, 5]. It is advisable to promptly influence the accommodation apparatus by carrying out functional optic-reflex trainings, which make it possible to increase the efficiency of the ciliary muscle, enhance the metabolic activity of the cells of the ciliary body, and improve the hemodynamics of the eye [1,4,7].

The purpose of the study is to reveal the prevalence of myopia and accommodation disorders in school-age patients in the region and to assess the medical efficiency of functional optic-reflex training of accommodation.

Material and methods

A retrospective analysis of the data of preventive examination of children - residents of the city of Tyumen, aged from 7 to 18 years with an identified pathology of the organ of vision in the period 2011-2018 was carried out. An annual sample of patients was carried out for the purpose of additional examination in an outpatient setting to confirm the diagnosis. An ophthalmological examination was carried out, including: visometry, skiascopy, accommodation study, perimetry, biomicroscopy, fundus ophthalmoscopy, refractokeratometry, ultrasound examination (USE) of the eyeball. Perimetry (study of the peripheral boundaries of the visual field, detection by cattle) was carried out on the perimeter of PNR-2-01 (Russia). Biomicroscopy was carried out using an "SL-140" slit lamp manufactured by "CarlZeiss Meditec AG" (Germany). Refractokeratometry was performed on a "HUMPHREY" autorefractometer (Japan). USE of the eyeball - on an Ocuscan R×P ultrasound machine from Alcon (USA). The method for determining the PRA indicator - a study of the adaptation of the eyes to visual loads at close range in negative diopters [1], was carried out in comparison with the age norm (-4.0 - -5.0 Diopters) [5]. Children diagnosed with Myopia underwent optical spectacle correction for medical reasons. When the diagnosis "Disorders of accommodation" or in combination with the diagnosis "Myopia" was made, courses of functional optic-reflex training were prescribed, depending on the type of accommodation disorders. Medical performance was assessed with at least ten sessions twice a year for three years. To interpret the results of the study, patients were divided into 4 groups depending on the diagnosis and the degree of myopia. Statistical processing of research materials was carried out using the STATISTICA 6 program.

Results and discussion

When analyzing the data subject to preventive examination of children in the region, an increase of 14.2% in the number of patients with reduced vision in comparison with years was revealed. The proportion of pathology in the period 2011-2018 and the distribution by age is shown in figure 1.
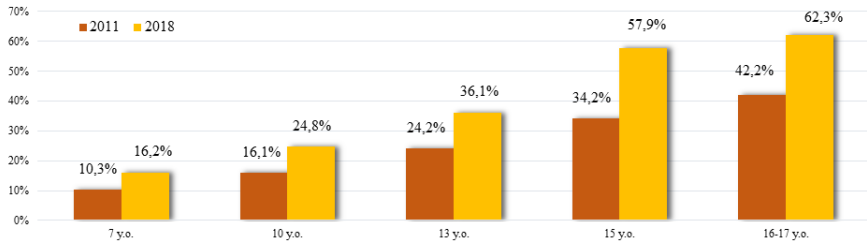
Figure 1. The proportion of pathology of the organ of vision in the period 2011-2018 and distribution by age

There is a significant increase in pathology in the age aspect and an increase at the age of seven by 5.9%, at 10 years old - 8.7%, at 13 years old - 11.9%, at 15 years old - 23.7%, from 16 to 17 years inclusive – 20.1%. The main part of all refractive pathology of newly diagnosed myopia and accommodation disorders falls on the age of ten (shown in figure 2.)
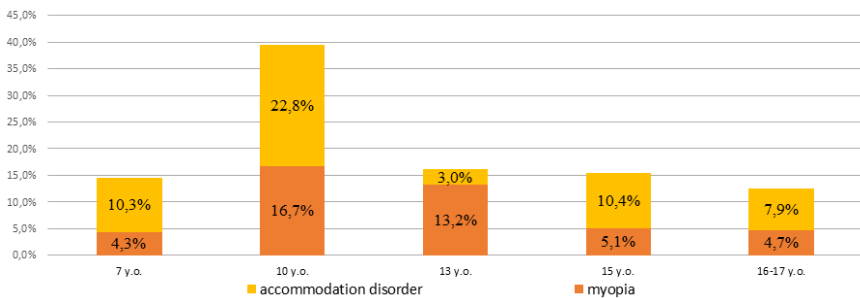
Figure 2. For the first time revealed myopia and accommodation disorders by age

At the age of 7 (10.3% of cases) and at the age of ten (22.8%), the diagnosis "Accommodation disorder" prevails, myopia is first detected in a smaller volume - 4.3% and 16.7%, respectively. At the age of 13, an increase in myopia was recorded up to 13.2% of cases, and significantly less (3.0%) violations of accommodation, because some of the patients with this diagnosis acquire myopic refraction. From 15 to 18 years of age, newly diagnosed myopia is detected almost equally in 5.1% and 4.7%, and the percentage of accommodation disorders decreases from 10.4 to 7.9%. During the comparison period over the years, the total number of children with myopia increased with a decrease in the number with accommodation disorders (displayed, respectively, in Figures 3 and 4 in terms of age.)
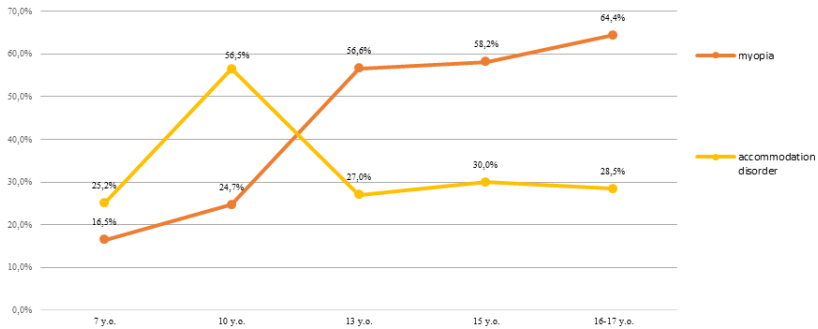
Figure 3. Dynamics of the established diagnoses "Myopia" and "Accommodation disorders" by age in 2011
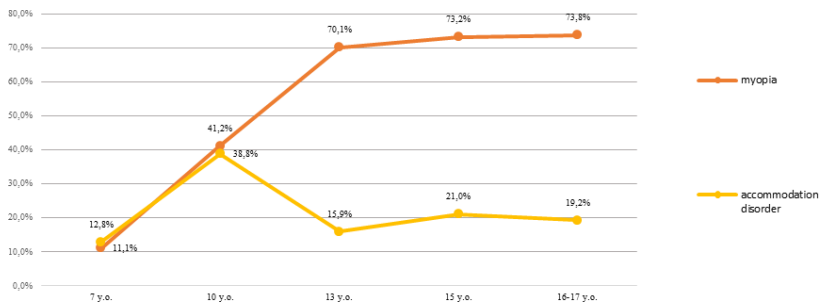
Figure 4. Dynamics of the established diagnoses "Myopia" and "Accommodation disorders" by age in 2018

When conducting a comparative analysis over the years, after the children were diagnosed, in 2011 at the age of seven to ten, a greater percentage of accommodation disorders was revealed - 25.2% -56.5%; smaller in 2018 - 12.8% -38.8%. Myopia at the age of 7 was detected with insignificant fluctuations - 11.1% -16.5%. In 2018, myopia was recorded 41.2% among 10-year-olds and further by age myopia prevails (56.6% - 2011, 73.8% - 2018) over accommodation disorders (15.9% - 2011, 28.5% - 2018).

Selected with established refractive diagnoses for treatment courses 721 patients (1442 eyes), average age of children 12±3.8. Gender differences were revealed with a predominance of women in 55.2% (398) cases; so at the age of seven by 6.8%, at 10 years old - there are no differences, at 13 years old - 7.6%, at 15 years old - no, at 16-17 years old by

8.8%. When distributed according to the degree of myopia, the prevalence of weak myopia was revealed in 53.8% of cases. Group 1 included 118 (16.3%) patients diagnosed with accommodation disorders, group 2 included 388 (53.8%) patients diagnosed with mild myopia, group 3 included 201 (27.9%) patients with diagnosed with "Moderate myopia", in group 4, 14 (1.9%) patients diagnosed with "High myopia". The dynamics of visual functions in these groups during treatment is presented in table 1.

Table 1

Dynamics of visual functions in the study groups before and after treatment

	Visual acuity			Maximum tolerable optical correction (Dptr)			Accommodation reserves (Dptr)	
	Before treat-ment	After treat-ment	Im-prov-ing visual acuity	Before treat-ment	After treat-ment	Im-prov-ing visual acuity	Before treat-ment	After treat-ment
1-st group n=118	0.44 ±0.5	0.57 ±0.2	0.13 ±0.25	1.8 ±0.4	0.8 ±0.3	1.0 ±0.2	2.0 ±0.6	6.6 ±0.7**
2-nd group n=388	0.25 ±0.5	0.4 ±0.2	0.15 ±0.25	2.9 ±0.6	1.48 ±0.5	1.41 ±0.4	2.11 ±0.3	7.5 ±0.25***
3-rd group n=201	0.09 ±0.3	0.16 ±0.3	0.07 ±0.3	4.85 ±0.4	4.1 ±0.3	0.75 ±0.5	2.4 ±0.4	6.45 ±0.3**
4-th group n=14	0.05 ±0.1	0.1 ±0.1	0.05 ±0.1	7.5 ±0.5	6.7 ±0.2	0.8 ±0.3	2.5 ±0.1	6.3 ±0.15**

Note: n - number of subjects; Dptr- diopter, **- $p<0.03$;***- $p<0.01$

When analyzing the data before treatment, higher visual acuity and the smallest maximum tolerable optical correction (in diopters) were recorded in groups 1 and 2, higher accommodation reserves in group 4, minimal in group 1, because with accommodation disturbances, most patients had accommodation weakness with reserves less than or equal to 0.5-0.75 Dptr. When analyzing the dynamics of visual functions in the groups, it was revealed: visual acuity increased more after courses of treatment in

patients with diagnoses of "Accommodation disorders" - group 1 and "Mild myopia" - group 2; a greater decrease in the maximum tolerable optical correction was recorded in group 2, and in a smaller amount - in group 3. In all groups, the following was noted: visual acuity 0.2±0.35 before and after treatment 0.3±0.2, an increase in visual acuity by 0.1±0.22, a decrease in the maximum correction before treatment from 4.26±0.32D to 3.27±0.33D after treatment by 0.99 ± 0.35D; an increase in the reserves of accommodation from 2.25±0.4D to 6.72±0.35D. When analyzing the data, there is a reliably significant (p<0.03) increase in visual functions after treatment, which is more pronounced in violation of accommodation and in mild myopia. The highest state of accommodation reserves can be achieved in groups 1 and 2. Diagnostics of accommodation revealed that with increased refraction in the range of a weak degree from 0.25 to 3.0 Doptr, the PRA indicator in patients of both sexes gradually significantly decreased (p<0.001): with myopia up to 1.0 Doptr - 3.76 Doptr, up to 3.0 Doptr - 3.55Doptr, and then with myopia of moderate and high degree decreases, so more than 3.0Doptr - 1.93Doptr and more than 6.0Doptr - 0.75Doptr. In the PRA study before treatment in all groups, the indicator was determined reliably (p<0.001) in girls by 0.51Doptr less than in boys, respectively - 1.63Doptr and - 2.14Doptr. Changes in the dynamics of the PRA indicator before and after treatment are presented in table 2.

Table 2

The dynamics of changes in the PRA indicator in the study groups before and after treatment

Terms of observation	Positive part (stock) of relative accommodation			
	Group 1 (n=118)	Group 2 (n=388)	Group 3 (n=201)	Group 4 (n=14)
Before treatment	-1.26 ± 1.17	-2.45 ± 1.31	-1.93 ± 1.62	-2.17 ± 1.42
After 1-st course of treatment	-5.2 ± 1.25	-5.07 ± 1.23	-3.99 ± 1.36	-4.44 ± 1.49
After 2-nd course of treatment	-6.0 ± 1.1	-5.02 ± 1.01	-3.46 ± 1.12	-4.1 ± 1.73
After 3-rd course of treatment	-5.35 ± 1.2	-4.37 ± 1.09	-2.76 ± 1.17	-4.02 ± 0.97
After 4-th course of treatment	-4.7 ± 0.9	-5.09 ± 1.19	-3.94 ± 1.48	-4.52 ± 1.48
After 5-th course of treatment	-4.8 ± 1.25	-4.85 ± 0.88	-2.59 ± 0.91	-4.75 ± 1.08

After 6-th course of treatment	-5.15 ± 1.01	-5.04 ± 1.28	-3.61 ± 1.56	-5.05 ± 1.82
Examination after 3 years from the start of treatment	-5.2 ± 1.3	-4.9 ± 0.74	-3.38 ± 0.81	-4.47 ± 1.33

Before treatment, a decrease in the PRA index from the age norm was found in all groups, but in groups 1 and 3 the indicator was the smallest. In comparison with other groups, there was a significant decrease in PRA in group 3 after all courses of treatment. After the 1st and 2nd courses of treatment, an increase in the indicator was recorded (up to the age norm and above) in all groups, but in the subsequent years in groups 1-2 and 4 the difference was insignificant, in group 3 there was a decrease in the indicator almost with each course of treatment, and in 4 - gradual increase. A high positive result was observed in children with the diagnoses of "Accommodation disorders" and "Mild myopia". The stability of the result of increasing PRA after treatment in groups 1, 2, 4 remained. Examination after 3 years from the start of treatment revealed that during regular courses it was possible to maintain the reserve of accommodation within the normal range in group 1 in 104 patients (88.1%), in group 2 - in 287 (73.9%), in group 4 in 9 (64.3%), in group 3, the indicator in 198 patients (98.5%) was below normal (less than 4.0 Dptr). After treatment, in 403 (55.8%) patients from all groups, an increase in PRA to the age norm was recorded, with the result being preserved.

Conclusion

Taking into account the identification in the region in a large number and with an increase over the years (12.8% - 56.5%) of seven-ten-year-old patients with accommodation disorders, it is necessary, taking into account the hereditary history, to timely determine the "risk group" - those threatened by the development of myopia. The increase in the development of myopia by the age of thirteen and an increase in its number in high school students observed over the entire observation period indicates the transition of functional disorders to organic pathology. The medical effectiveness of the treatment performed: a significant improvement in visual functions (increased visual acuity, a decrease in maximum optical correction, an increase in accommodation reserves, an increase in PRA to the age norm while maintaining the result) proves the necessity and effectiveness of regular courses of functional optical reflex training. Treatment is more effective in children with the diagnoses of "Accommodation disorders" and

"Mild myopia", which makes it possible to achieve stabilization of the state in the process of managing patients to control myopia.

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ON THE ISSUE OF RHINOSINUSOGENIC COMPLICATIONS OF THE ORBIT IN CHILDREN (LITERATURE REVIEW)

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Abstract. The article highlights the issues of rhinosinusogenic complications of the orbit depending on gender characteristics, age, types of modern visualization, treatment methods according to modern scientific sources.

Keywords: rhinosinusogenic complications of the orbit, childhood

The proximity of the paranasal sinuses, nasal cavity and orbit from the anatomical and physiological points of view determines the possibility of rhinosinusogenic complications. The increase in the incidence of orbital rhinosinusogenic complications over the years suggests the continuing urgency of the problem. Among the various types of orbital complications, the leading place (about 60%) is occupied by reactive edema of the soft tissues of the orbit. In second place in terms of the frequency of complications are periostitis and subperiosteal abscess. Less often, the most severe complications are observed - an abscess and phlegmon of the orbit, thrombosis of the veins of the orbit.

Rhinogenic complications can occur in the area of the orbits, bones, or soft parts of the frontal sinus wall. A possible consequence of frontal sinusitis is osteomyelitis. If the frontal bone is affected, there is a risk that

the infection can spread to the periosteum of the inner surface of the skull through the medullary spaces and blood vessels. [1]

Among the diseases of the nasal cavity and paranasal sinuses, the most common urgent ENT-pathology is rhinosinusitis (54.5% are acute and 45.5% are exacerbations of chronic). The maxillary sinuses are 1.5 times more likely than the frontal ones to be involved in the inflammatory process. Orbital and intracranial complications were detected in 9.8% of patients with rhinosinusitis, 22.8% of patients require urgent surgical intervention. Men and women need urgent hospitalization in an ENT-hospital almost equally often (51.5 and 48.5%, respectively), the age of patients in most cases is the most able-bodied (20–49 years, 59.8%). In addition, the seasonality of the increase in the incidence rate is characteristic (autumn - spring, 82.6%) [3]. They are more common in children than in adults [4]. Orbital infections caused by acute sinusitis are rare in newborns and infants and can lead to extremely dangerous complications. Over the past 50 years (1959-2012), according to the results of a systematic review on the diagnosis and treatment of orbital complications secondary to acute sinusitis in newborns and infants, 11 cases were identified (age from 10 to 74 days), the number of boys and girls was almost the same [3].

Orbital complications can have a traumatic, inflammatory, allergic, or autoimmunological cause. The microflora responsible for childhood orbital complications is evolving, with staphylococci being the most common pathogens, followed by streptococci species [4].

Preseptal cellulite is the most common complication (61.5%), followed by orbital cellulite (23%), subperiosteal abscess (11.5%), orbital abscess (3%) and cavernous sinus thrombosis (1.5%) [11]. The incidence of rhinogenic intracranial complications (meningitis and brain abscess) is insignificant, the mortality rate is very high and reaches 30%. Orbital complications account for about 80% of all complications and can lead to optic neuritis, cavernous sinus thrombophlebitis, or life-threatening intracranial complications [2].

Orbital complications require early diagnosis and complex treatment. Surgical treatment (endoscopic drainage) in this patient group is of paramount importance as the only child who did not receive drainage died [3]. At the same time, according to the results of another scientific study, it was revealed that endoscopic endonasal surgery or traditional external ethmoidectomy is not always effective, and intracranial complications (intracranial abscess) may develop [5]. Cellulite does not require an obligatory orbital drainage. Usually, an orbital abscess is drained through an external incision and sinus surgery is performed at the same time to remove the infection. [6]

The stage and origin of orbital complications are determined using rhinoendoscopy, ophthalmologic examination, and computed tomography of the orbit and paranasal sinuses.

Subperiosteal inflammatory disease, subperiosteal abscess and orbital cellulitis are the most common consequences of both acute and chronic sinusitis. Early objective assessment of orbital inflammation is essential to prevent blindness. Computed tomography (CT) is a study of choice in the diagnosis of the discussed pathological conditions [6]. Conventional radiography does not play any role in assessing the complications of acute sinusitis in a pediatric patient [7]; in such cases, visual assessment using CT and MRI is required, with the obligatory inclusion of the axial one and should include images of the paranasal sinuses and, if necessary, the orbits and the brain (with attention to the cavernous sinus).

CT or MRI is the diagnostic basis for deciding on appropriate treatment [12]. In patients with intracranial complications, MRI is more reliable (97%) in determining the diagnosis than computed tomography (87%) or clinical results (82%). CT remains the standard diagnostic technique for sinusitis. Both diagnostic methods have improved management tactics and made it possible to achieve better results in the treatment of patients with rhinosinusogenic complications [9,10]. The use of echography has also found its application in patients with rhinosinusogenic complications and is a screening method in the differential diagnosis of exophthalmos [8].

Important in the treatment of rhinogenic inflammatory orbital complications is the effect on the primary focus of the disease, that is, on the inflamed paranasal sinus. Therapeutic measures aimed only at the affected orbital tissues are doomed to failure. Currently, most authors prefer a complex method of treatment, covering a wide range of measures, depending on the nature of the lesion of the orbit and paranasal sinuses. It is advisable to consider the tactics of treatment of rhinogenic orbital complications separately in acute sinusitis and in exacerbation of the chronic process [12].

No improvement or worsening of symptoms within 24-48 hours and advanced stages of orbital complications are indicated for surgery. In the presence of orbital complications, all patients undergo combination therapy - intravenous antibiotics and surgery within 24 hours. Orbital infection is the most common complication of ethmoiditis. There is no single approach to defining the criteria for the effectiveness of limited interventions in individual sinuses. However, some authors believe that orbital cellulite in children is not an absolute indication for immediate surgical intervention. Preseptal and postseptal cellulitis can usually be treated non-surgically,

while orbital abscess and cavernous sinus thrombosis can be treated surgically [10].

Conservative treatment should include antibacterial, hyposensitizing drugs, decongestants, mucoactive drugs, physical treatments [12]. In recent years, more and more data have been published on the positive effect of the use of immunomodulators and topical corticosteroids in the complex treatment of sinusitis. A feature of the treatment of vein thrombosis of the tissue of the orbit and cavernous sinus (as well as suspicions of this pathology) is the use of direct anticoagulants.

Experience has shown that not only timely and justified radical surgery, but also the postoperative management of patients, is of great importance for the prognosis, speedy recovery and prevention of complications. Competent, pathogenetically justified treatment of patients in the postoperative period, taking into account the microflora and its sensitivity to antibacterial drugs, as well as drainage of surgical wounds and synechiae in the nasal cavity, significantly reduce the length of hospital stay [12].

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LIFETIME METHODS OF STUDYING ANATOMICAL STRUCTURES OF THE HEART AS A WAY TO REDUCE THE DISCREPANCY BETWEEN CLINICAL AND PATHOANATOMIC DIAGNOSES

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Abstract. The expert of the quality of medical care carried out planned and targeted quality examinations in accordance with the current legislation of 170 cases. During the examination, the patient's management tactics were taken into account in accordance with the standards of medical care, or clinical recommendations, compliance with lifetime and pathoanatomic diagnoses. The discrepancy of these diagnoses with improper medical care was revealed in 18% of cases. Important importance is attached to the lifetime method of research in chronic pathology of the cardiovascular system.

Keywords: intravital research methods, quality examination, underlying disease, background disease, cerebrovascular pathology.

Relevance

The main task of medical activity, including in the primary level, is to preserve the health of the population, which is reflected in Federal Law No. 323 FZ of November 11, 2011 "On the basics of protecting the health of citizens in the Russian Federation". However, the examination of primary medical documentation shows a certain percentage of improper provision of medical care to both adults and children. Improper provision of medical care can lead to complications, the formation of chronic pathology, or death in adults and in childhood [4].

The purpose of the study

Determination of the role of lifetime methods of studying the anatomical structures of the heart as a method that increases the percentage of coincidence of clinical and pathoanatomic diagnoses with the development

of a rehabilitation plan for patients with chronic pathology of the cardiovascular system within the framework of dispensary observation. To achieve the goal , it is necessary to solve the following tasks:

1. Study the primary documentation of patients receiving primary medical care on an outpatient basis.

2. To study the clinical recommendations of medical care for chronic pathology of the cardiovascular system.

3. To evaluate the results of treatment in a group of patients who underwent instrumental research methods according to clinical recommendations and patients who did not undergo instrumental research methods, followed by the development of a rehabilitation plan within the framework of dispensary observation.

4. To analyze pathoanatomic conclusions depending on the tactics of treatment and examination of patients with chronic pathology of the cardiovascular system.

Materials and methods

The material for the study was the primary medical documentation of 170 patients who received primary health care outpatient care. As primary medical documentation, the cards of patients receiving primary health care and protocols of pathologic and anatomical autopsy were used. The fatal outcome was registered in stationary conditions, or at the therapeutic site. Patients are divided into gender-age and clinical-statistical groups with the same heading ICD-10. The research method used is a planned medical-economic and targeted examination of the quality of the cases presented. The quality examination was carried out in accordance with the criteria for assessing the quality of medical care approved by the Order of the Ministry of Health of the Russian Federation on May 10, 2017 "On approval of criteria for assessing the quality of medical care". All patients underwent intravital imaging methods - ultrasound Dopplerography of the main arteries of the head (USDG) and hearts. In case of changes in the parameters of USDG, radiation neuroimaging methods of research were performed – magnetic resonance imaging with contrast, cerebral angiography. Patients complaining of dizziness underwent an otoneurological examination in accordance with clinical guidelines or standards of care for cerebrovascular pathology.

During the lifetime planned examination of primary medical documentation, the following defects in the provision of medical care were identified (Table 1).

Table 1.

Defects in the provision of medical care to patients of the experimental group during the planned quality examination

Type of defect according to the list	Frequency of occurrence of the defect	
	abs.	%
Improper provision of medical care – non-compliance with standards and clinical recommendations	45	40,9
Absence of taking on dispensary registration	61	55,4
Lack of optimal drug treatment	12	10,9

As can be seen from Table 1, the most frequent defect in the provision of medical care was the lack of dispensary observation of patients with chronic cardiovascular pathology. The defect in the provision of medical care, occurring in almost half of the patients, was improper provision of medical care, in particular, non-compliance with standards or clinical recommendations when providing outpatient medical care for angina pectoris. 12% of patients did not receive optimal treatment aimed at eliminating the symptoms of the disease and preventing complications.

In vivo research methods for angina pectoris according to clinical recommendations [2] are laboratory studies and instrumental diagnostics. Among the instrumental methods of research, echocardiography should be performed in all patients, in which it is possible to detect changes in the normal anatomical structure of the valves, the myocardium of the left ventricle, the ascending aorta. Ultrasound examination of the carotid arteries reveals a violation of the anatomical structure of the valves in the form of stenoses. Chest radiography in angina pectoris allows you to suspect an aneurysm of the ascending part of the aortic arch. In addition, given the possible pain syndrome with angina, it is possible to differentiate it in diseases of the musculoskeletal system. ECG monitoring makes it possible to detect violations of the conduction system of the heart in the form of arrhythmia, extrasystole and blockage of the legs of the Gis bundle. The most significant for the diagnosis of possible complications is coronary angiography and multispiral tomographic angiography of the coronary arteries can detect stenoses in the proximal and distal sections of the coronary arteries.

More than half of the patients in the experimental group underwent the above-mentioned in vivo research methods, and optimal drug treat-

ment was prescribed. Sclerotic changes in cerebral vessels with uneven distribution of blood flow were detected in 42% of patients. According to a number of authors [3], the uneven distribution of blood flow in certain variants of the structure of the arterial circle of the large brain can lead to the occurrence of vascular aneurysms, the rupture of which ends in such a terrible complication as hemorrhagic stroke, and with a pathologically caused decrease or cessation of blood flow through the supply vessels, it can cause the development of transient transient cerebral ischemic attacks and ischemic stroke. The main complaints presented by patients were complaints of dizziness (76%), noise in the head (64%), memory impairment (46%), headache (21%), decreased performance (15%). In 98% of cases, there was an increase in blood pressure to 160 and 100 mm Hg and above. The above complaints were made equally often by male and female patients ((p<0,01)). In the course of diagnostic measures, obesity 1-3 degrees (28%), fasting hyperglycemia (21%), an increase in triglycerides (56%), an increase in LDL cholesterol (62%), and an increase in the atherogenicity coefficient of more than 4 (32%) were detected. More than half of the patients had a combination of the above elements of the metabolic syndrome. According to the clinical recommendations for cerebrovascular pathology, all patients underwent MRI SCAN of the brain with contrast. The classical structure of the vessels of the Willisian circle was not revealed in any patient from the observed group.

When conducting a targeted examination of fatal cases of patients in the control group, it was revealed that in vivo research methods were not carried out, or were partially carried out, respectively, optimal drug treatment was not prescribed. In this group, in comparison with the experimental one, the frequency of complications was revealed much more often (18% suffered a myocardial infarction). The life expectancy after diagnosis verification in the experimental group was more than 15 years, whereas in the control group it was 8-10 years.

In the protocols of pathoanatomic autopsy of patients of the experimental group, the discrepancy of the main diagnosis (the disease itself or through complications became the cause of death) was revealed in 0.9% of cases, whereas in the control group - 18%.

Conclusions

The results obtained allow us to draw the following conclusion.

1. Lifetime research methods are the main ones for verifying a clinical diagnosis.

2. The protocols of pathoanatomic studies indicate a significant dis-

crepancy in the main diagnosis in the control group (18%), where in vivo methods of research were not carried out, or were carried out partially and there was practically no discrepancy between the clinical diagnosis and the pathoanatomic in the experimental group (0.9%), where in vivo methods of research were carried out in full.

3. In order to increase life expectancy after diagnosis verification, a planned examination of the quality of medical care is necessary, the purpose of which is to assess compliance with standards of medical care, or clinical recommendations where lifetime research methods are justified.

4. More than half of the examined patients presented cerebrovascular complaints – the most common were dizziness (76%) and noise in the head (64%). Almost all the subjects had elevated systolic and diastolic blood pressure (160 and 100 mm Hg and higher). More than half of the patients had a combination of symptoms of the metabolic syndrome: obesity of 1-3 degrees, excess of the reference values of lipid metabolism, fasting hyperglycemia.

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COVID 19 AND STROKES IN CHILDREN: A CLINICAL CASE OF STROKE IN A CHILD AS A RESULT OF A PREVIOUS CORONAVIRUS INFECTION

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Abstract. Child with severe COVID-19 have blood clotting disorders that mimic other systemic coagulopathies associated with severe infections, such as disseminated intravascular coagulation (DIC) or thrombotic microangiopathy. Article presents case history of the child S., 3 years old, was admitted to the NCMChW with Ischemic stroke after COVID-19. Child was a depressed consciousness, the presence of seizures of a tonic-clonic nature with loss of consciousness, affects, against the background of an increase in body temperature to 39 degrees Celsius, with the limitation of movement in extremities, presence of hemorrhagic rashes on the lower extremities. Due to the severity of her condition, she was hospitalized in the intensive care unit of the NCMChW. After the received treatment, the patient's condition improved.

Keywords: COVID-19 in child, associate with Ischemic stroke,

Introduction

Children with COVID-19 mainly suffer from respiratory tract infections, some of them develop a more severe and systemic disease characterized by treatment-resistant hyperthermia, acute lung injury with acute respiratory distress syndrome (ARDS), shock and multiple organ dysfunction, which lead to high mortality [3].

Many children with severe COVID-19 have blood clotting disorders that mimic other systemic coagulopathies associated with severe infections,

such as disseminated intravascular coagulation (DIC) or thrombotic micro-angiopathy [4]. Coagulopathy in patients with COVID-19 increases the risk of mortality [5]. In addition, the significance of COVID-19 clotting disorders is becoming increasingly evident, since a significant proportion of patients with severe COVID-19 develop, sometimes unrecognized, venous and arterial thromboembolic complications, such as cerebrovascular complications [6, 7].

Cerebrovascular disease with acute hemiplegia in children is not uncommon, and every effort should be made to improve the outcome for these patients. Acute hemiplegia and impaired consciousness are the most common initial symptoms [1].

Kawasaki disease, which occurs mainly in children under 5 years of age, has typical clinical signs: prolonged fever, conjunctivitis, dry chapped lips, cervical adenopathy, diffuse skin rash affecting the trunk and limbs, subsequent peeling of the toes and fingers, and edema. In addition to the classic manifestations of Kawasaki disease, patients are more likely to show symptoms of digestive disorders, shock and myocardial damage [2].

In connection with the above, we provide this description of the clinical case of a sick child. Child S., 3 years old, admitted to the NCMChW in a depressed consciousness, the presence of seizures of a tonic-clonic nature with loss of consciousness, affects, against the background of an increase in body temperature to 39 degrees Celsius. There was a limitation of movement in the left extremities, the presence of hemorrhagic rashes on the lower extremities. Due to the severity of her condition, she was hospitalized in the intensive care unit of the NCMChW.

Medical history: According to the mother on July 28, 20, in the morning, the child became lethargic, lacked appetite, and there was a sharp restriction of movement in the left extremities.

On the same day, they turned to the clinic for m / f, where a single seizure attack was observed against the background of an increase in body temperature up to 39oC. Diazepam was administered intramuscularly, analgin + diphenhydramine intramuscularly. The child was sent to the Ak-Talin district territorial hospital, and was admitted to the intensive care unit for the severity of the condition, where he was from 28/07/20 to 30/07/20.

Due to the lack of dynamics (depressed consciousness, high body temperature, not decreasing against the background of NSAIDs, hemorrhagic rash), the child was transferred to the intensive care unit of the Naryn Regional United Hospital. An MRI scan of the brain was performed. Diagnosed with meningoencephalitis of unspecified etiology. ACVA by ischemic type. Bilateral pneumonia ". The child was in the hospital from

30.07.20 to 03.08.20. Received treatment: antibacterial, hormonal, infusion and symptomatic therapy.

After the received treatment, no positive dynamics was observed, the child's condition remained serious, the body temperature was in the range of 37.7-38.5C. At the insistence of the parents on 03.08.20 the child was transferred to the National Center for the Protection of Mothers and Children (Bishkek), where he was hospitalized in the ICU. The result of the PCR analysis of COVID 19 is positive from 04/08/20. From that moment on, the child was isolated, further therapy was aimed at treating the coronavirus infection.

Obstetric anamnesis: Child from 6 pregnancies 5 births (1 spontaneous miscarriage). Pregnancy proceeded against the background of toxicosis up to 3-4 months, my mother suffered ARVI in the 1st trimester (she took Paracetamol and Insti tea). Was registered from the 3rd week of pregnancy. IUI analysis is negative. During pregnancy, blood pressure increased in the 2-3 trimester (my mother does not remember the numbers). Childbirth at 39 weeks, emergency, by KS due to an increase in blood pressure to 210 mm Hg. A girl was born. VLOOKUP 3400 g. She screamed at once, not immediately attached to the breast - for 2 days, she was actively sucking. There was no jaundice. Received vaccinations - according to the calendar. Heredity is not burdened. Family marriage denies. During pregnancy I took iodomarin, elevit, folic acid.

Neurological status: Consciousness of coma (3 points on the GCS). Does not react to inspection. Does not react to sound stimuli. The skull is rounded. BR is closed. Pupils with an average diameter, D = S, the reaction of the pupils to light is absent, D = S. There is no movement of the eyeballs. No strabismus, no nystagmus. The face is symmetrical. Muscle tone is hypotonic in all extremities, D <S. Left-sided hemiplegia. Tendon reflexes are reduced on the right, absent on the left. Stiff neck.

NIHSS at the time of admission to the NCMChW (7th day of stroke) - 26 p.

NIHSS on day 10 of stroke - 26 p.

NIHSS on day 17 of stroke - 21 p.

Somatic status: The condition is severe due to neurological symptoms and signs of intoxication.

The skin and visible mucous membranes were pale in color, hemorrhagic rash was observed on the lower extremities until the 11th day of illness. Peeling of the skin of the pads of the fingers and toes, myasthenia gravis appeared on the 25th day of illness. The occipital and parotid lymph nodes were enlarged, painless. The pharynx is hyperemic. Nasal breath-

ing is free. Breathing is hard over the lungs. Heart sounds are muffled, rhythmic, no noise. The abdomen is soft on palpation, the liver and spleen are not enlarged. The stool is liquid, without pathological impurities, up to 6-7 times a day. Urination through a urinary catheter. Nutrition through a nasogastric tube until 22 days of illness. After swallowing was restored, the child had bulimia.

Laboratory data:

Study of a smear for PCR COVID 19 - positive (from 04/08/2020);

Blood test for SARS CoV - 2, IgG COVID 19 - CP 7.8; antibodies to coronavirus SARS CoV - 2, IgM COVID 19 - KP 1.07 (from 08.21). Ferritin - 82.1; ng / mlD - dimer 5.10 mg / ml; Fibrinogen "A" - 9.4 g / l bp. recalcification 115, PTV 20, PTI 80.0; INR 1.2; APTT 40.

total protein - 40.0 g / l; procalcitonin 0.6 ng / ml

CRP is negative.

Instrumental data:

1. MRI from 07/31/2020. - signs, most likely, as a manifestation of encephalitis on the right. Ischemic stroke is not excluded.

2. MRI angiography from 08/07/2020 - a picture of the depletion of the terminal branches of the middle and posterior cerebral arteries on both sides. Hypoplasia of the transverse sinus on the left.

MRI
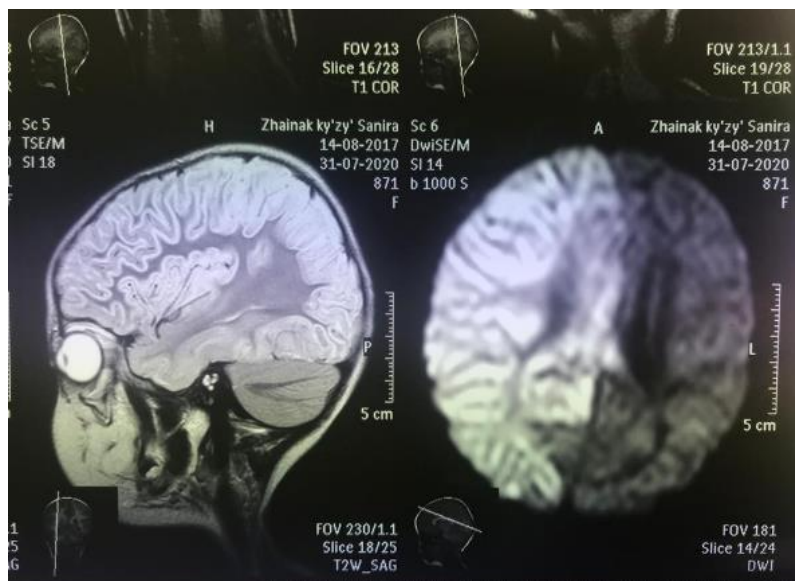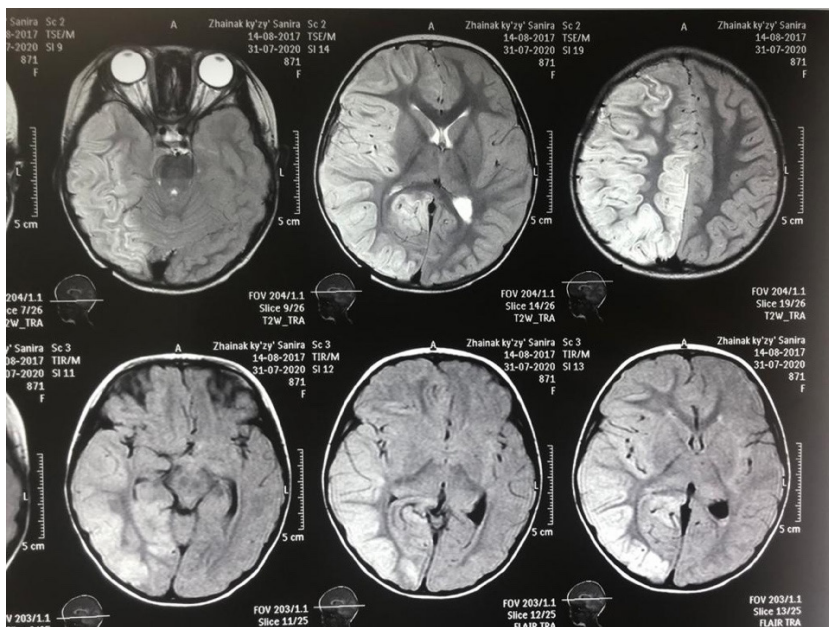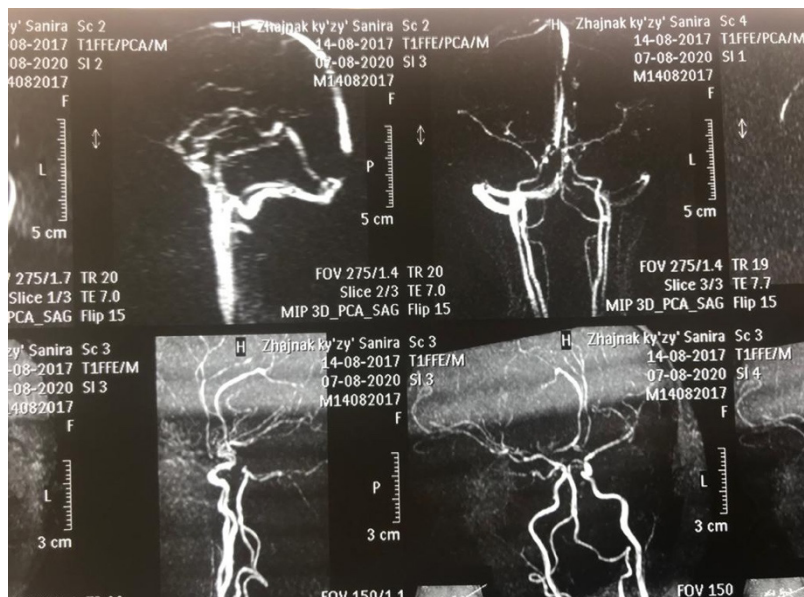
6. Ultrasound of the brain - thrombosis in the BSMA on the right

7. ECHO KG - MNMK tachycardia.

8. ECG - sinus rhythm. Heart rate 160 beats. in min. EOS is rejected to the right. Incomplete right bundle branch block.

9. X-ray of the chest organs: bilateral hilar pneumonia.

Consultations of narrow specialists

2. Nephrologist - reactive urinary syndrome. Proteinuria. Microhematuria. Protein-free edema with diarrhea.

5. Gastroenterologist - antibiotic-associated diarrhea.

6. Cardiologist - Minimal mitral insufficiency.

7. Oculist - bilateral scleritis.

8. ENT - acute pharyngitis.

Taking into account the history, somatic and neurological status of the child, the results of laboratory and instrumental examination methods, a clinical diagnosis was made: stroke. Ischemic stroke in the basin of the middle cerebral artery on the right, with diffuse lesion of the right hemisphere, due to a previous coronavirus infection. Left-sided hemiplegia. Concomitant diagnosis: Nephropathy. Antibiotic-associated diarrhea. Moderate iron deficiency anemia. Acute pharyngitis. Bilateral conjunctivitis. Minimal mitral valve insufficiency.

The patient's treatment was conservative in accordance with the stan-

dards of therapy for coronavirus infection in the Kyrgyz Republic according to the fourth version of the clinical guide: pathogenetic (antiplatelet and hormone therapy), symptomatic (NSAIDs, infusion and antibiotic therapy).

After the therapy, there was a positive trend: Ferritin - 30.84 ng / ml; D-dimer 0.53; Fibrinogen A - 4.6. On the chest x-ray in dynamics, infiltration was determined on both sides at the stage of resorption. NIHSS (36 days of stroke) - 13 p.

Conclusion

Thus, this clinical case emphasizes the importance of considering in pediatric practice the concept of stroke due to coronavirus infection. We inform about a case of acute cerebrovascular accident in a 3-year-old child who has applied to the hospital of the National Center for Children's Medicine and Dentistry in Bishkek. The girl was diagnosed with a severe infection caused by coronavirus infection (SARS-CoV-2), with the addition of respiratory disorders.

At the initial stage of the disease, the child showed lethargy, weakness, and lack of appetite. Then, for the first time, convulsions appeared against the background of an increase in body temperature to 39 ° C, a hemorrhagic rash appeared on the lower extremities (which lasted until the 11th day of illness), diarrhea, parents noted a sharp restriction of movement in the left extremities, shortness of breath, the child's consciousness was impaired. On the 7th day of illness, due to a sharp deterioration in the condition, the parents went to the hospital, where the child was transferred to the intensive care unit by the severity of the condition, in the consciousness of a coma (3 points on the GCS), the score on the scale (NIHSS) was 26 points, rigidity was noted occipital muscles, protein-free edema, signs of respiratory failure, a picture of bilateral conjunctivitis, pharyngitis. The results of blood tests showed coagulopathy (D-dimer 15.10 mg / ml, fibrinogen "A" - 9.4), signs of inflammation, the test result for detecting SARS-CoV-2 was positive. MRI data of the brain described possible meningo-encephalitis of unspecified etiology, ischemic stroke. On the radiograph of the OGK, bilateral pneumonia was noted, the ECHO of the KG showed MNMK. The patient's treatment was conservative in accordance with the standards of therapy for coronavirus infection in the Kyrgyz Republic according to the fourth version of the clinical guide: pathogenetic (antiplatelet and hormone therapy), symptomatic (NSAIDs, infusion and antibiotic therapy). The score on the scale (NIHSS) on day 10 was 26 points. A week later, a second MRI scan of the brain was taken, the picture of which showed depletion of the terminal branches of the middle cerebral arteries

on both sides, hypoplasia of the transverse sinus on the left. On the 17th day of the disease, the calf on the scale (NIHSS) was 21 points. After the received treatment, the patient's condition improved, general activity appeared, and we noted the addition of peeling of the fingertips, increasing kinorexia. The child was transferred to a rehabilitation facility.

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THE IMPORTANCE OF CRYSTALLOGRAPHY IN EARLY DIAGNOSIS OF CHOLELITIASIS

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Summary
The aim of the study
Determining the dependence of the bile microstructure of the degree of bile destabilization of and on the age of patients with the I stage (pre-stone) of the cholelithiasis.

Materials and methods. 396 patients with stage I of cholelithiasis (CL) were examined. 1 group consisted of 125 young patients (25-44 years), 2 group - 164 middle-aged patients (45-59 years), 3 group - 107 elderly patients (60-74 years). In verification of the diagnosis, in addition to anamnestic and general clinical data, the results of ultrasound examination (USE) of the gallbladder, the study of the physical and chemical properties of bile were used. Crystallography was used to study the morphological pattern of the gallbladder bile.

Results. In the evaluation of the bladder bile of patients with stage I of cholelithiasis, we found a decreasing of the angle of the tilt of the liquid crystal lines, as well as the appearance of optically active inclusions, such as branched dendrites with plate branches, matted-fiber aggregates, shield-shaped aggregates and short-branched dendrites. With an increase in the tendency of bile to stone formation, the optical activity of microcrystals increases, lamellar druses and branched platelike aggregates are determined. The degree of violation of the bile microstructure increases with increasing age of patients.

Conclusion. Crystallography is high sensitive, but at the same time an easy-to-perform method and can be widely used in early diagnosis of cholelithiasis.

Keywords: early diagnosis of cholelithiasis, lithogen bile, bile morphometry.

Introduction

One of the actual problems of clinical gastroenterology is cholelithiasis (CL), that has a high and increasing prevalence from year to year, a pronounced negative impact on social activity and quality of life [1, 2].

The nonspecific nature of clinical manifestations, asymptomatic course complicate the timely clinical diagnosis of cholelithiasis.

A promising direction for today is the study of the phase composition of various biological fluids of the body, based on the idea of the participation of liquid crystals in the pathogenesis of a number of diseases [3,4]. Biological fluids, in particular, bile, under certain conditions, are able to crystallize with the formation of different patterns, depending on the nature of the pathological process, which allows them to be used for diagnostic purposes [5, 6].

The aim of the study

Determining the dependence of the bile microstructure of the degree of bile destabilization and on the age of patients with the I stage (prestone) of the cholelithiasis.

Material and methods

We examined 396 patients with stage I of CL (classification of the Central Research Institute of Gastroenterology, 2001), that developed on the background of various biliary pathology (biliary tract dysfunction, chronic non-calculous cholecystitis). The calculation of the required number of observations was carried out on the basis of calculating the sample size with the level of statistical power of the study p=0.80 and was performed using statistical software packages Statistica 6.1 from Stat Soft, that allow evaluating the sample population as corresponding to a normal distribution. The age of the patients ranged from 25 to 74 years. There were 145 men (36.7 %), 251 women (63.3 %).

When patients were included in the study, the inclusion and exclusion criteria were taken into account. Criteria for inclusion of patients in the study:

1. Patients male and female aged 20-60 years with stage 1 of CL.

2. Availability of signed informed consent.

Criteria for excluding patients from the study:

1. Pregnancy and lactation.

2. Severe condition.

3. Oncological diseases.

4. Mental disorders.

5. No signed informed consent.

According to the WHO classification (2012), the 1st group consisted of 125 young patients (25-44 years), the 2nd group-164 middle-aged patients (45-59 years), the 3rd group-107 elderly patients (60-74 years). The groups were formed by random and typological sampling, the examined groups of patients were balanced by gender.

In the verification of the diagnosis, along with anamnestic and general clinical data, the results of ultrasonic examination (USE) of the gallbladder ("SONIX OP" (Canada)) were taken into account. All patients underwent multifractional duodenal probing followed by macroscopic, microscopic, morphometric, biochemical and physical examination of bile.

The total concentration of bile acids in the bile – BAb, cholesterol - CSb [7], was determined, the bile lithogenicity index - cholato-cholesterol coefficient (CCC) was calculated. According to the method developed for saliva and adapted by us for bile, the study of surface tension (STb) and viscosity (VZb) was carried out. The specific gravity of bile (Gb) was determined using a hydrometer for urine AU (Ukraine), the acidity of bile (pHb) - by pH-metry.

To study the morphology (microstructure) of cystic bile (portion B), crystallography (polarization microscopy) was used - a research method based on the ability of a number of crystal-forming substances to form various structures. The preparations were viewed by simple polarization in transmitted light using a Leica DM 2500 microscope (lens x 3.5) with a Leica DFC 420 digital camera and Leica applications software 3 hours and 24 hours after its preparation. Using the program "ImageJ" (Free Ware), the features of the bile microstructure were determined, the images were entered into a computer, analyzed and processed using the original VIDEO test computer program.

The control group included 50 practically healthy individuals aged 20 to 50 years who did not have complaints from the digestive system.

The obtained results were analyzed using statistical processing programs Microsoft Excel 2010 and PSPP. The normality of the distribution was checked using the Kolmogorov-Smirnov and Shapiro-Wilk criteria, the distribution was approaching normal. Due to the distribution close to normal, parametric statistical methods were used in the study. The data is presented in the form of M+SD. When assessing the statistical significance of the differences (p) and comparing quantitative indicators in the two groups, the Student's criterion (T) was used. The differences between the groups were taken as statistically significant with the probability of validity of the null hypothesis that there is no difference between the groups $(p) < 0,05$.

The method of correlation analysis with the calculation of the correlation coefficient (r) according to the Pearson formula was used in the work.

Results

USE of the gallbladder revealed biliary sludge in 100% of patients, in bile microscopy we found crystals of cholesterol and calcium bilirubinate in 72.6%. All the examined patients showed changes in the biochemical composition of bile corresponding to the first stage of CL (Table 1).

Decreasing of BAb that stabilizes the colloidal state of bile is the starting point of CSb deposition and bile supersaturation. It is logical that the index of its lithogenicity (CCC) is deteriorating. As can be seen from the table, the risk of cholelithiasis increases with age.

Table 1.
The data of the physico-chemical study of bile in healthy people and in patients with CL

Data	Control group (n=50)	1 group of patients (n=125)	2 group of patients (n=164)	3 group of patients (n=107)
CSb (mmol/l)				
Portion B	7,56+0,07	27,76+2,14*	29,96+2,45*	19,96+2,15*
Portion C	3,63+0,06	14,99+2,16*	14,87+1,33*	8,41+1,54*
BAb (mmol/l)				
Portion B	54,33+0,14	49,35+2,17*	48,93+2,67*	26,02+1,34*
Portionя C	20,76+0,20	18,01+2,23	17,37+2,31	10,43+2,01*
CCCж (un)				
Portion B	7,15+0,07	2,77+0,04*	1,63+0,07*	1,3+0,07*
Portion C	6,14+0,10	1,45+0,04*	1,16+0,07*	1,2+0,07*
VZb (un)				
Portion B	2,74+0,20	3,78+0,29*	4,15+0,3*	4,41+0,56*
Portion C	2,52+0,02	3,22+0,03*	3,81+0,19*	4,23+0,8*
STb (mkN/m)				
Portion B	22,31+0,15	22,95+2,15	24,16+2,03	28,34+1,16*
Portion C	22,05+0,14	24,99+1,19*	25,96+1,19*	28,04+2,41*
Gb (un):				
Portion B	1019,70+0,32	1023,00+2,45*	1030,00+2,15*	1036,0+2,03*
Portion C	1010,22+0,18	1010,00+2,14	1016,00+1,34*	1023,0+2,0*
pHb (un)				
Portion B	7,72+0,03	6,48+0,03*	5,87+1,04*	5,00+1,01*
Portion C	7,62+0,06	6,94+0,18*	6,19+1,06*	5,39+1,00*

Note: n - the number of observations; *- P<0.05 confidence in comparison to the control.

At the early stage of CL in young people, the metabolism of exogenous cholesterol is slower, in the elderly, the activity of 7-alpha-hydroxalase, involved in the synthesis of bile acids from cholesterol, decreases [8,9]. We obtained similar data: in group 1, the lithogenicity of bile is mainly associated with an increased level of CSb, in group 3 - with a reduced level of BAb, in group 2 – these processes are relatively balanced.

In the study of the physico-colloidal properties of the bile of the examined patients (Table.1) an increase in VZb and Gb were determined, which is consistent with the literature data [10, 11]. The lithogenicity of bile, determined by its physical characteristics, also increases in older age groups.

We received interesting data of the correlation analysis between the biochemical and physico-colloidal properties of bile (Table 2). The established negative relationship between Gb, VZb, STb and CCCb indicates that the rheology of bile affects lithogenesis: its thickening, reducing solubility, contributes to the deposition of cholesterol crystals, agglomeration and nucleation. In addition, the positive correlation between pH and CCCb suggests that gallstone formation is most likely in an acidic environment.

Table 2.
Correlation between the cholatocholesterol coefficient and indicators of the physico-colloidal properties of bile

Data	Gb B	VZb B	STb B	pHb B
CCC «В»	-0,4	-0,48	-0,39	0,32
P	<0,0001	>0,05	<0,0001	<0,05
Data	Gb C	VZb C	STb C	pHb C
CCC «С»	-0,4	-0,48	-0,39	0,32
P	>0,05	<0,0001	<0,0001	<0,0001

Note: p is the reliability of the correlation indicator.

The process of gallstone formation goes through the following stages: supersaturation, crystallization and crystal growth. The cholesterol-saturated vesicle is unstable, during aggregation it forms liquid crystals. Next, nucleation and precipitation of solid crystals (cholesterol monohydrate) occurs, which is a key link and the basis of lithogenesis [8,10,12].

Widely branched crystals with liquid crystal lines (LCL) were found in the bile of healthy individuals by crystallography (Fig.1A), the angle of inclination of which was 98.97+2.92°.

The bile microstructure of patients with stage I CL was age-dependent. The 1st group (Fig. 1B) was also characterized by widely branched crys-

tals, but there was a decrease in the angle of inclination of the LCL to 46.16+3.67° (confidence (p) in relation to the control <0.01) and indistinctness of the structure (11.2%).
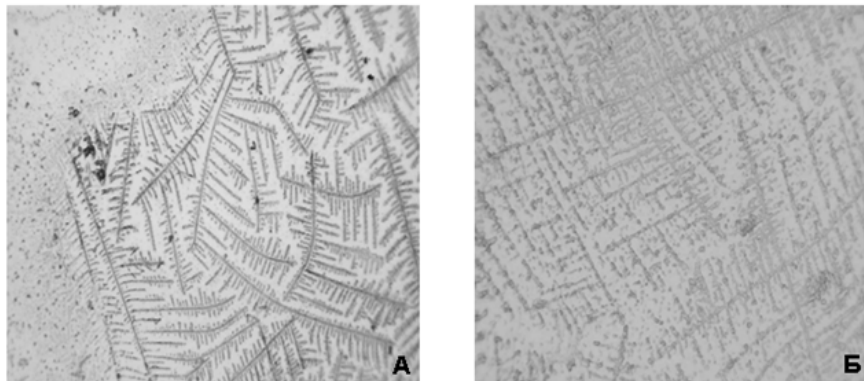
Figure 1. Bile crystallograms: A – bile of healthy individuals; B - bile of group 1 patients

In addition, inclusions with varying degrees of optical activity were determined in the pre-stone stage of the CL. For the 1st group (Fig.2: A, B) with the lowest degree of lithogenetic bile, crystals with low optical activity - branched dendrites (39.2%) and matted fibrous aggregates (49,6%) – were determined.
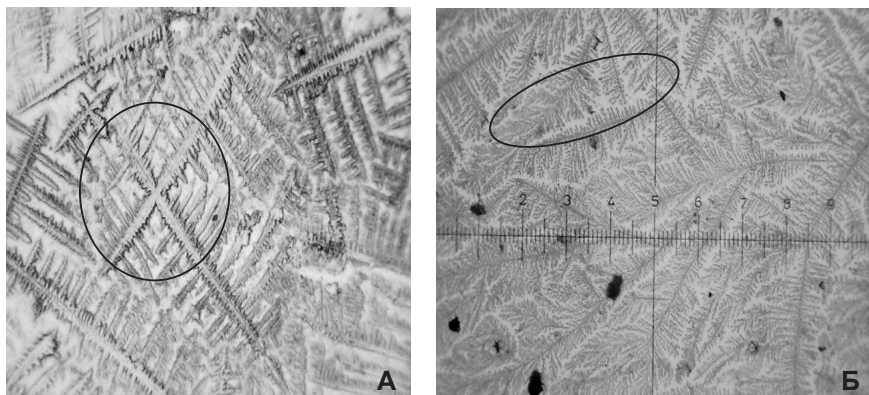
Figure 2. Bile crystallograms of group 1 patients: A - branched dendrites; B - tangled fibrous aggregates

For the 2nd group (Fig.3: A, B), with a greater degree of lithogenetic of bile, crystals with high optical activity - the shield-shaped aggregates (41.7%) and short branched dendrites (58,5%) were typical.

The microstructure of even more lithogenic bile of group 3 patients (Fig. 4: A, B) was represented by lamellar druses and branched platelike aggregates (39.2% and 47.6%, respectively).
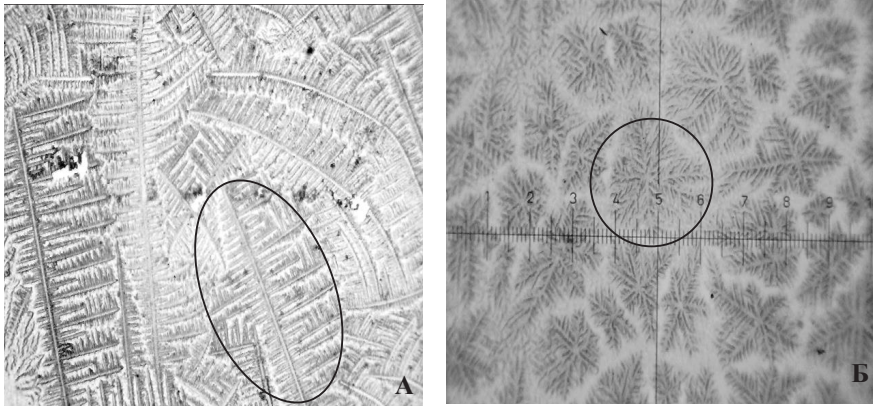
Figure 3. Bile crystallograms of patients of 2 groups: A - shield-like aggregates; B - short branched dendrites
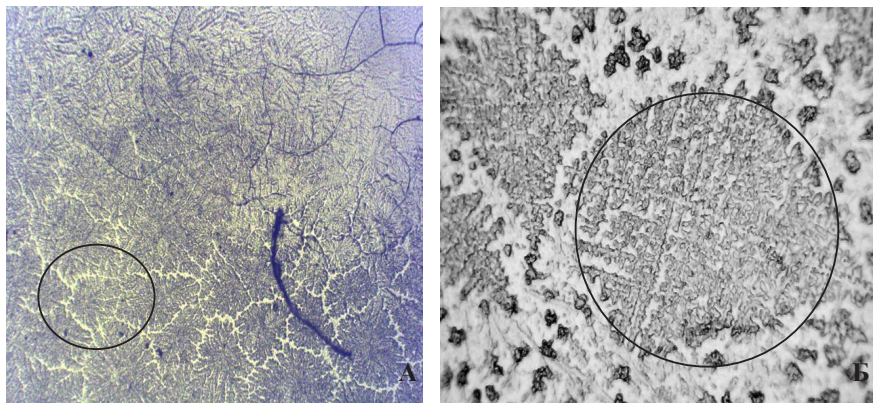
Figure 4. Bile crystallograms of patients of 3 groups: A - lamellar druses, B - branched platelike aggregates

Discussion

The revealed morphotypes most likely correspond to promicrolites and microlites formed in stage I of the CL, since they are absent in healthy individuals. Lithogenic bile is bile that tends to precipitate cholesterol with the formation of liquid crystal structures with high optical activity [5]. These found crystal-optical structures have a selective morphology in accordance with age and with the degree of lithogenicity of bile. With an increase in the lithogenicity of bile, the optical activity of crystals increases, its tendency to precipitate cholesterol with the formation of liquid crystal structures elevates [11,13].

Unlike the physico-chemical study of bile, which determines only the quantitative and qualitative content of its components, crystallography allows to detect deeper changes in the structure of bile.

Conclusions

1. Bile crystallography is a highly sensitive, but at the same time easy-to-perform method and can be widely used in the early diagnosis of CL.

2. Shield-like aggregates and short-branched dendrites in bile are transitional forms (promicrolites) and precede the formation of microliths - microcrystals in the form of lamellar druzes and branched platelike aggregates.

3. The degree of destabilization of bile, violations of its microstructure increase with increasing age of patients.

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TACTICS OF MANAGEMENT OF PATIENTS WITH COMPLICATIONS OF BILE DISEASE, MANIFESTED BY MECHANICAL JAUNDICE DEPENDING ON STAGES OF ITS DEVELOPMENT

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Introduction

Since 2000s over 2.5 million various operations on bile ducts are performed in the world every year [1-3]. In Russia, more than 60 thousand people are operated on for cholelithiasis every year [4]. For the last several decades, this especially concerns the management of patients with cholelithiasis complications in form of mechanical jaundice (MJ). In practice, the two-stage variant of surgical treatment of jaundice should be considered the most widespread, which consists in performing first low-traumatic decompression of the biliary system, and only then-radical surgical intervention [5-9]. At the same time, some researchers note that there are disadvantages of this approach: combining several stages of treatment can add up and risks of intra- and postoperative complications [10]. Several studies [11-13] note the advantages of using a personalized approach in the treatment of patients with cholelithiasis and MJ, which allows reducing the overall number of complications and mortality. It is worth mentioning that comorbidity in patients with bile disease complications is a key aggravating factor and gets worse as the stages of the pathological process develop [13]. Many authors consider that in some complicated situations even with full technical equipment and perfected endoscopic equipment it is not always possible to perform lithoextractions from bile ducts without fail, which makes people remember "old", tested surgical "macro technologies" [12-19]. How to overcome these problems is the unresolved issue of treatment of MJ of non-tumor genesis. That is the subject of this present report.

The objective of the study to improve treatment results of patients with complications manifested by MJ depending on the stages of its development.

Research objectives: 1. To reveal the most frequently used methods of biliary tract drainage in patients with MJ. 2. To determine the most frequently used methods for decompression minimally invasive interventions in MJ of non-tumorous origin that is accompanied by the least number of complications and lethal outcomes. 3. To determine the most frequent surgery performed for and MJ. 4. To evaluate the application of the developed scheme of MJ treatment choice at different stages.

Material and Methods

537 patients were admitted to the clinic of hospital surgery of Kabardino-Balkarian State University from 2010 to 2019. Most of them, 277 (51.6%), were admitted a week after the onset of the disease. A month or later after the onset of the disease, 123 (22.9%) people were admitted. Other patients were admitted at different periods of the disease. Division of patients by sex revealed that 301 (56.1%) of them were women. There were fewer men: 236 (43.9%). The ratio of women to men in all groups was comparable. The vast majority of patients were over 60 years of age: 207 persons, or 38.5%. The number of persons under 30 years of age was 43 (8%). Among them, there were 5 (0.9%) persons aged 18 and 19 years. There were 49 (9.1%) persons older than 80 years of age. The study involved dividing all patients with MJ into two groups. The first (control) group included 249 patients who were admitted between 2010 and 2014. The mean age of these patients was 64±5 years. This group did not take into account the stage of jaundice when choosing treatment tactics. The second (main group) included 288 patients who were admitted start out from 2015. The average age of these patients was 65±5 years. The choice of management tactics for these patients changed, and the staging of MJ was taken into account. The majority of patients with MJ had generalized atherosclerosis as comorbidity, which was observed much more frequently than other diseases - in 412 (76.7%) patients. IHD occurred in 284 (52.9%) patients, hypertension in 99 (18.4%), obesity in 85 (15.8%), and diabetes mellitus in 30 (5.6%) patients. Other comorbidities were markedly less common: kidney disease was detected in 39 (7.3%) patients, stomach disease in 27 (5%), liver disease in 21 (3.9%), lung disease in 23 (4.3%), and intestinal disease in 11 (2%). Various types of hernia were observed in 14 (2.6%) patients, postthrombotic syndrome - in 9 (1.7%) patients. A combination of two comorbidities was observed in 64 (12%) patients, three in 33 (6.1%), four in 21 (3.9%), and five in 10 (1.9%) patients. Choledocho-

lithiasis with MJ without comorbidities occurred in 111 (20.7%) patients. All 537 patients with MJ of non-tumor genesis underwent various minimally invasive interventions draining biliary tracts. The technique of endoscopic retrograde cholangiopancreatography (ERCP) was "classical" and was performed using "Olympus" TJF-30 fibrogastoduodenoscope with 12.5 mm external tube diameter, 4.2 mm operating channel, side optics. During endoscopic papillosphincterotomy (EPST), arc (2.0 cm string length) and endoscopic papillotomy were used. Extraction catheters (balloon dilators) with 5 Ch. diameter and 260 cm length were used for manipulations in the ducts. For external drainage of bile, we used MTW endoscopy nasobiliary drains, plastic biliary, and pancreatic stents 3 Ch. The guidewire length was 220 cm. After ERCP and EPST 412 (76,7%) patients underwent nasobiliary drainage of the bile ducts with drains up to 220 cm long. For stenting, we used plastic biliary and pancreatic stents "MTW endoscopy" 3-5 Ch, 5 cm long - pancreatic and 7-11 cm long - biliary. Percutaneous transhepatic retrograde external drainage of bile ducts was performed according to the recommendations of the European Society of Gastrointestinal Endoscopy (2013) [13-15]. In such cases for puncture and external bile drainage, we used Chiba 18-22 fn needle, soft guide with J-tip in 0.035 inch and rigid guide in 0.035-0.038 inch. A 7-10 fn bougie was used to dilate the puncture canal. Direct decompression of the bile duct was carried out using 8-10 fn "pig tail" type drainage. The operation was carried out under local anesthesia. Novocaine infiltration included the entire abdominal wall, liver capsule, and liver tissue under it. The choice of optimal localization of the external orifice was additionally clarified by ultrasound. Such method of biliary tract drainage as "Rendezvous" was used in 11 (2%) cases. Laparoscopic cholecystostomy was performed under visual control using the "Olympus" video endoscopic rack. Gallbladder puncture was performed through the edge of the liver, the drains had a cuff fixing the drainage in the gallbladder lumen. After biliary tract decompression 500 (93,1%) patients underwent various surgical interventions. A non-randomized, single-center, prospective, simple blind clinical trial was performed. Statistical processing of the obtained material was performed using a computer application package (Word 2013, Excel 2013, Statistica 8.0). Since the distribution of values in the samples differed from normal, methods of nonparametric analysis were used for statistical processing. Mann-Whitney nonparametric criterion (U) was used as a criterion of reliability of difference between two independent groups. To compare medians of signs for each group we used median criterion for independent samples with pairwise comparison. The hypotheses of an equal distribution of traits and equality of their medians

across groups were rejected for all traits with a significance level of 0.05 and a 95% confidence interval. No significant Spearman rank correlations with a value greater than 0.8 modulo within-group or across data were found to be less than 0.05.

Results and Discussion

All patients were firstly decompressed biliary tree by different methods in the clinic since 2010. ERCP and EPST were the major part of biliary decompressions, 412 (76,7%) were completed by nasobiliary drainage of the choledochal (Table 1).

Table 1.

The character of decompressive minimally invasive interventions performed in MJ of non-tumor genesis

Operations	Number and % of operation	Complications	Mortality with %
ERCP, nasobiliary drainage	412(76,7%)	28(6,8%)	3(0,7%)
ERCP, stenting	56(10,4%)	-	-
PTCA	39(7,3%)	2(5,1%)	-
Ante- и retrograde drainage «Rendezvous »	15(2,8%)	1(6,7%)*	-
Laparoscopic cholecystostomy	15(2,8%)	1(6,7%)*	1(6,7%)*

Note: hereinafter, * indicates statistical reliability (p<0.05).

Less frequent stenting was performed after ERCP and EPST - 56 (10.4%) cases. Percutaneous transhepatic cholangiostomy (PTC) was performed in 39 (7.3%) patients. In 15 (2,8%) patients it was transformed into a "Rendezvous" technique involving ante- and retrograde drainage of bile ducts. In emergency cases, laparoscopic cholecystostomy was performed in 15 (2,8%) patients. Postoperative complications after ERCP and EPST developed in 28 (6,8%) patients, which resulted in lethality in 3 (0,7%) cases. Complications that ended lethally after laparoscopic cholecystostomy was related to the severity of the underlying pathological process in the gallbladder and biliary passages. In 37 (6.9%) patients due to the severity of the condition due to concomitant diseases minimally invasive drainage of the biliary tract remained the only intervention. In this category of patients, the severity of anesthesia risk according to the ASA classification was grade IV and higher. In such cases, we followed the principle "from simple to complex" that helps to provide the simplest and the fastest

decompression of the biliary system in an emergency. Thus, laparoscopic cholecystostomy was used more often (15 cases), more rarely - ERCP, EPST, and nasobiliary drainage (19 cases). Percutaneous transhepatic biliary decompression was rarely performed (3 cases) due to its complexity and risk of complications. Currently laparoscopic cholecystectomy is the most frequent surgery for calculous cholecystitis and MJ, it was performed in 245 cases. In another 79 (15,8%) patients it was accompanied by external drainage of choledochal, in 51 (20,8%) cases it was performed more often according to Pikovsky, in 28 (11,4%) cases - according to Coeur (p<0,05).

The majority of such patients underwent ERCP, EPST with the extraction of concrements from the ducts: 166 (61,9%) patients. Cholecystectomy from mini access was performed in 189 (37,8%) patients. In the majority of operated 116 (63,1%) patients it was completed by choledochal drainage according to Pikovsky, and in 26 (13,1%) patients - by Kerr (p <0,05), which is technically more difficult and less reliable, but provides qualitative decompression and control of biliary patency. No deaf suture of choledochus was applied. In 41 (20,7%) patients choledochal patency after removal of concrements was disturbed: at X-ray investigation, the contrast was not emptied because of stricture. During mini access surgery in 6 (3.0%) patients concrements in the papilla were detected, which required its transduodenal dissection and removal of the concrement. In 66 (13,2%) cases of patients with GER and MJ complications, such purulent-septic processes were revealed during the operation which required urgent wide laparotomy, destructive focus removal, sanation, and drainage of abdominal cavity and retroperitoneal space. In 10 (15,2%) people of this group, such changes were found during cholecystitis surgery that after intraoperative diagnosis they immediately required conversion - laparotomy. In 34 (41,5%) cases besides MH they had gangrenous cholecystitis, purulent cholangitis, peritonitis, pancreonecrosis which forced them to make laparotomy intervention (p<0,05).

To analyze the effectiveness of the considered tactics in the management of patients with and MJ, it became reasonable to compare the results of treatment methods before and after the creation of comprehensive individualized tactics, taking into account the stages of jaundice development. From the 2000s and onwards, the two-stage tactic for the management of patients with MJ has been traditional for most emergency surgical departments, and it has been used for all categories of MJ patients. In determining the indications for decompression preference was given to ERCP with EPST and choledochal drainage, and in the treatment of biliary tracts - minimally invasive technologies in the form of laparoscopic

cholecystectomy. In case of impossibility to perform or excessive danger of intraoperative complications development we switched to mini-access or laparotomy, which was called a conversion. We did not use data on the stages of jaundice when determining indications for decompression and surgery, that is why we did not take into account peculiarities of the preoperative preparation and time intervals between the drainage manipulations on the biliary tracts. At the final choice of the method of intervention, the emphasis was always made on minimally invasive technologies. On this basis, it was decided to make up the first (control) study group, which included 249 patients, out of those admitted in 2010-2014. Since 2015 the tactics of management of patients with (bile stone disease) BSD complications in the form of MJ has changed in the clinic: as a result of the determination of jaundice stages, there was a change like preoperative preparation, aimed mainly at hepatotropic positive effect, controlled by the level of transaminases in blood. Development of clear laboratory benchmarks of the liver tissue state allowed to determine the efficiency of conservative treatment, to specify the terms of biliary system drainage, its types, terms, and types of surgical interventions taking into account specific clinical and laboratory indicators - benchmarks of jaundice stages. To personalize treatment, biliary drainage and operations were classified into emergency, urgent, and planned. In the second (investigated) group consisting of 251 people in the first stage of MI, called cholestasis (n = 129), decompression of the biliary tree and the following endoscopic cholecystectomy were practically combined: the gallbladder was removed the next day after effective concrements removal and drainage of choledoch because no additional treatment was required before the radical intervention. When the second stage, hepatocytolysis, developed (n = 93), treatment was started with hepatotropic therapy, and the time interval between the biliary tree drainage and cholecystectomy increased depending on the transaminases level in the blood (hepatocytolysis elimination) up to 7 days, on average. The third stage, cholangitis (n = 36) was regarded as an urgent indication for surgical intervention - the same as in purulent-septic pathological processes in the abdominal cavity. In this regard, the patients underwent urgent biliary tract decompression with their sanation with antiseptics. In the case of progressing cytolysis (transaminases) and markers of the purulent-septic process (leukocytosis, Calf-Calif Index, middle mass molecules, circulating immune complexes) the indications for emergency surgery "on vital signs" were put, and antibacterial and detoxification infusion therapy was continued if anesthesia contraindicated. The data of both groups were comparable by age, sex, and comorbidities. Types of surgical

interventions in both groups were as follows: laparoscopic, mini access operations according to M.I. Prudkov technique, and traditional laparotomy interventions. Technical aspects of choledochotomy, methods of concrement extraction, intraoperative diagnostic options, drainage methods in laparoscopy, and mini-laparotomy were similar (Table 3).

Table 3.
Possibilities of various types of operations on gallbladder and ducts in non-tumorous breast cancer

Charasteritics of the feature	Laparotomy	Laparoscopy	Mini-access
Access size	Over 10sm	3-4 punctures of 1-1,5sm each	the length 4-5sm
Areas of work	Epigastrium, mesogastrium, subcostals	Upper and middle floors as much as possible, the abdomen	Only projection of gallbladder and hepatic fold
Inspection method	Visual	Videosystem	Visual
Operating conditions	Rough stretching of tissues with massive hooks	Carboperitoneum	Tissue traumatization only in the projection of gallbladder and ligament
Inspection capabilities	The abdomen cavity	The abdomen cavity	The projection of gallbladder and choledochus
The effect on concomitant diseases	are exacerbated	Pulmonary and cardiovascular diseases are exacerbated	No effect on the chest, heart or lungs

Opportunities to view the operation area are the best in laparoscopy when there is a magnified image of the gallbladder, its vessels, bile ducts, ligament elements as well as almost all other abdominal cavity organs. They are the worst in mini-access: you can see only the operation site. During laparotomy, the situation can change depending on the length and type of access. Due to the small size of the operative area, the mini-access does not affect the accompanying lung and heart disease. Other types of surgery can cause a comorbid syndrome in the form of decompensation of cardiovascular disease. Thus, any type of minimally invasive surgery used to treat non-tumorous breast cancer has its advantages to achieve a

positive result, but there are also disadvantages. The main one is lengthening of intervention time in technically complex cases and high risk of intraoperative complications in such situations. Consideration of various surgical possibilities and developing factors of surgical aggression provides an opportunity to individualize operative treatment of non-tumorous breast cancer depending on its stage. In cholestatic jaundice "operations of choice" are minimally traumatic endoscopic surgeries, accelerating the rehabilitation process and giving good cosmetic results. Traditional laparotomy cholecystectomies are not contraindicated in such patients in "difficult" technical cases requiring conversion. Such patients are fully prepared for surgery without latent or obvious hepatic or any other insufficiency of vital organs. In the cytolytic stage of jaundice, wide laparotomy is the most dangerous, because the body's defense mechanisms are in a state of maximum tension due to latent and obvious hepatic insufficiency, characterized by hypertransaminemia. In such cases laparoscopic cholecystectomy is desirable, but the best, especially in the unfavorable background of concomitant diseases, is the use of mini-access on the background of continuing -hepatotropic therapy. The argument in favor of such a choice should be minimal impact on the cardiac and respiratory systems against the background of changes in the liver and easy drainage of the bile ducts. Mini-access surgery has an advantage over laparoscopic and laparotomy techniques also in cases with scar changes of the anterior abdominal wall and adhesions in the abdominal cavity. In cholangitis surgical aid is urgent and taking into account the severity of a patient's condition it may be limited to decompression and sanitation of bile ducts only. In such cases, low-traumatic endoscopic surgeries are not always feasible, because qualitative sanitation of purulent focus with their help is technically a very difficult task, not feasible in all clinics, time-consuming, and requires good equipment with quality instruments. In such cases, when the patient's condition is serious, we have to limit ourselves to the most reliable and accessible decompression of biliary tree - laparoscopic cholecystostomy. As far as the situation is urgent, after drainage of biliary tracts it is more rational to apply traditional laparotomy, cholecystectomy, choledochotomy, and choledocholithotomy in "untouchable" patients to remove the inflammatory focus. Taking into consideration principles of individualization of treatment we have developed the scheme of BC treatment method choice at different stages, where the main criteria for surgical intervention are reflected: indications, contraindications, and conditions. Usually, they are additionally characterized by anesthesiologists by determining the severity of the patient's condition before surgery according to the ASA classification. Table 4

shows the comparative characteristics of complications and mortality in the analyzed groups. The number and percentage of complications changed as a result of the personalized tactical approach. Their total number and percentage in the second group decreased approximately by half: from 11 (9,7%) to 6 (4,6%) (p0,05), with external drainage of the choledoch from 7 (17,9%) to 4 (10%) (p0,05). When performing cholecystectomy from mini access the range and volume of surgical interventions since 2015 was wider. If in group 1 external drainage of the cholecystectomy was performed almost always: in 92 (98.9%) cases, in group 2, the external drainage was performed almost twice as rarely in 50 (52.1%) cases (p<0.05). But mini access with internal drainage was performed more frequently: choledochoduodenoanastomosis was done from mini access in 40 (41,7%) patients, and transduodenal papillosphincterotomy and papilloplasty from mini access in 6 (6,3%) patients (p <0,05). Laparotomy, cholecystectomy, drainage of choledoch and abdominal cavity were performed in case of purulent-inflammatory changes in gallbladder and ducts, in subdiaphragmatic space, pancreas, and retroperitoneum. It should be noted that in the 2nd group the number of such patients decreased from 43 (17,3%) to 23 (9,2%) (p0,05). Laparotomy cholecystectomies with choledoch and abdominal cavity drainage were performed in the most severe patients, therefore, lethality rates in the 1st and 2nd groups improved slightly: they were 4,6% and 4,3% respectively (p>0,05). There was no mortality after conversion. Even when cholecystoduodenoanastomosis was applied under unfavorable conditions of cholangitis in the 1st group, the mortality rate was 5.6%, and in the 2nd group, there was no mortality.

Table 4

Presents the types of complications and mortality in the analyzed groups

Operations	1st group		2nd group			
	Abs. number (n=249)	Complications Patient and %, mortality %	Abs. Number (n=251)	Complications Patient and %, mortality %	Abs. number	Complications Patient and %, mortality %
Laparoscopic cholecystectomy, total:	113 (45,4%)	11(9,7%)*/ 3,5%	132 (59,9%)	6(4,6%)/ 1,5%	245 (49%)	17(6,9%) */2,4%
After ERCP	74 (65,5%)	4(5,4%) /1,4%	92 (69,7%)	4 (4,3%)/0	166 (67,8%)	8(4,8%) /0,6%

+ Pikovsky drainage	22 (19,5%)	4(18,2%) */4,5%	29 (22%)	3(10,3%) */3,4%	51 (20,8%)	7(13,7%) */3,9%
+ Kerr drainage	17 (15,0%)	3(17,6%) */11,8%	11 (8,3%)	1(9,1%) */9,1%	28 (11,4%)	4(14,3%) */10,7%
Holecystectomy from mini-access, total	93 (37,3%)	10(10,8%) */3,2%	96 (38,2%)	6(6,2%) /4,2%	189 (66,1%)	16(8,5%) /3,7%
+ Pikovsky chole-dochal drainage	88 (94,6%)	9(10,2%) */2,3%	28 (29,2%)	1(3,6%)/0	116 (61,4%)	10(8,6%) /1,7%
+ Kerr drainage	4 (4,3%)	1(25%) /25%	22 (22,9%)	1(4,5%) /4,5%	26 (13,7%)	2(7,7%) */7,7%
Choledoduodenos-tomy from mini-access	1 (1,1%)	0	40 (41.7%)	3(7,5%) /5%	41 (21,7%)	3(7,3%) /4,9%
Transduodenal pap-illosphincterotomy and plasty from mini-access	0	0	6 (6,3%)	1(16,7%) */16,7%	6(3,2%)	1(16,7%) */16,7%
Laparotomy, chole-cystectomy, chole-dochal drainage and abdominal cavity, total:	43 (17,3%)	5(11,6%) */4,6%	23 (9,2%)	2(8,7%) /4,3%	66 (13,2%)	7(10,6%) */4,5%
Post-conversion laparotomy	7 (16,3%)	0	3 (13%)	0	10 (15,2%)	0
Laparotomy for widespread puru-lent-necrotic pro-cesses	18 (41,9%)	4(22,2%) */5,6%	16 (69,6%)	2(12,3%) */6,2%	34 (51,5%)	6(17,6%) */5,9%
Choledochoduode-noanastomosis	18 (41,9%)	1(5,6%) /5,6%	4 (17,4%)	0	22 (33,3%)	1(4,5%) /4,5%
TOTAL	249 (49.8%)	26(11,6%) */3,6%	251 (50,2%)	14(5,6%) /2,8%	500	40(8,0%) /3,2%

When examining the data in the table, a wide variety of complication types can be noted, with local purulent processes accounting for the smallest proportion, accounting for 10 (4.0%) cases in the control group and 7 (2.8%) in the study group (p < 0.05). Abdominal and retroperito-neal purulent-necrotic complications occurred with equal frequency in both groups: 13 cases accounting for 5.2%, but in the study group they were

concentrated in the group with cholangitis: a quarter of cases. Organ and systemic complications differ by half: after the implementation of personalized tactics, they decreased from 26 (10.4%) cases to 14 (5.6%) (p < 0.05). The second thing that draws attention is the "shift" of the number of complications to the group of patients with cholangitis, where the number of purulent local complications decreased from 7 (2.8%) cases of wound suppuration to 5 (1.9%) cases in the study group after the implementation of a personalized approach (p < 0.05). In abdominal inflammatory-septic processes, the number of complications decreased from 13 (5,2%) cases to 7 (2,8%) (p<0,05), that is, by half in persons with postoperative peritonitis. The majority of such complications in the study group - 4 (11,1%) cases, were operated with cholangitis. The third peculiarity of complications development was the involvement and insufficiency of all the main organs and systems. And in the study group, the number of cases of such complications even increased from 7 (2,8%) to 14 (5,6%) (p<0,05), which was caused by organ failure again in patients with cholangitis - the most severe group subjected to surgical treatment.

Table 5.
Types of complications and mortality in the analyzed groups

Complications	1st group (n= 249)	2nd group – personalized approach, taking into account the stages of MJ (n=251)			
Local purulent					
		cholestasis (n=129)	cytolysis (n=93)	cholangitis (n=36)	Total in group 2
Wound fester	7 (2,8%)	1 (0,8%)	3 (3,2%)	2 (5,6%)	5(1,9%)
Abdominal wall phlegmon	3 (1,2%)	-	-	2 (5,6%)	5(1,9%)
Total	10 (4,0%)	1 (0,8%)	3 (3,2%)	4 (11,1%)	7(2,8%)
Abdominal and retroperitoneal purulent-necrotic complications					
Postoperative peritonitis	13 (5,2%)	-	3 (3,2%)	4 (11,1%)	7(2,8%)
Pancreonecrosis	8 (3,2%)	-	1 (1,1%)	4 (11,1%)	5(1,9%)
Mesenteric vascular thrombosis	3 (1,2%)	-	-	1 (2,8%)	1(1,9%)
Peritoneal phlegmon	2 (0,8%)	-	-	1 (2,8%)	2(0,8%)
Subhepatic and hepatic abscess	4 (1,6%)	-	-	3 (8,3%)	3(1,2%)

Total	13 (5,2%)	-	4(4,3%)	9 (25%)	13 (5,2%)
Organ and systemic complications					
Cardiac insufficiency	7 (2,8%)	1 (0,8%)	2 (2,22%)	4 (11,1%)	7 (2,8%)
Respiratory failure	7 (2,8%)	-	1 (1,1%)	4 (11,1%)	5 (1,9%)
Cerebral circulatory failure	2 (0,8%)	-	2 (2,2%)	1 (2,8%)	3 (1,2%)
Liver failure	15 (6%)	-	3 (3,2%)	4 (11,1%)	14 (5,6%)
Renal insufficiency	3 (1,2%)	-	1 (1,1%)	2 (5,6%)	3 (1,2%)
Total	7 (2,8%)	1 (0,8%)	3 (3,2%)	4 (11,1%)	14 (5,6%)
Total with postoperative complications	26 (10,4%)	1 (0,8%)	3 (3,2%)	9 (25%)	14 (5,6%)
Mortality	9 (3,6%)	-	3 (3,2%)	4 (11,1%)	3 (2,8%)
Total	249 (49,8%)	156 (62,2%)	60 (23,9)	35 (13,9%)	251 (50,2%)

Conclusions

1. Laparoscopic cholecystostomy was used more often for biliary tract drainage in patients with MB, more rarely - ERCP, EPST, and nasobiliary drainage. Percutaneous transhepatic biliary decompression was rarely used because of its complexity and risk of complications.

2. At decompression minimally invasive interventions for mechanical jaundice of non-tumor origin, the least number of complications and lethal outcomes were registered at ERCP with nasobiliary drainage and percutaneous transhepatic drainage, on this basis, we believe, that these methods should be more widely used at this pathology.

3. Laparoscopic cholecystectomy is the most frequent operation at cholelithiasis and MJ, it is accompanied by external drainage of choledochal according to Pikovsky - in 20,8% of cases, according to Coeur - in 11,4% of cases.

4. Application of the scheme of choice of cholelithiasis treatment at different stages allows to decrease the number of complications from 9,7% to 4,6%; in the group of operations after ERCP, EPST - from 5,4% to 4,3%, with external drainage of choledochal - from 17,9% to 10%.

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THE INFLUENCE OF ERGOGENIC AND PHYSICAL MEANS OF POTENTIATING PHYSICAL PERFORMANCE ON THE ENERGY METABOLISM OF NEURONS IN THE CEREBRAL HEMISPHERES OF THE BRAIN IN QUALIFIED ATHLETES

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Abstract. The article assesses both a separate effect of biologically active additives based on beekeeping products and an amino acid complex, and their complex application together with the course effect of low-intensity laser radiation on the level of energy metabolism of neurons in the cerebral hemispheres of the brain of qualified athletes. It was found that the level of its constant potential directly depends on the predominant type of autonomic regulation of the heart rate.

Keywords: biologically active additives, low-intensity laser radiation, sprints, qualified athletes, neuroenergy mapping, brain.

Relevance

The reserve capabilities of the heart muscle to a large extent ensure the success of the athlete's body and reflect the level of the functional state of the cardiovascular system. At the same time, as sportsmanship grows, sudden cardiac arrest syndrome increases (J.A. Drezner, 2019; E.A. Gavrilova, 2021). Risk factors are canalopathies, ventricular arrhythmias, hypersympathicotonia, decreased heart variability. One of the preventive measures, in our opinion, can be the inclusion of dietary supplements in sports nutrition, as well as the use of low-energy laser radiation

(S.V. Moskvin, 2019; P.A.Terekhov, 2021).

In this regard, in the future, the influence of ergogenic and physical means of potentiating physical performance on the functional state of neurons in the brain of athletes in a state of relative physiological rest was analyzed, taking into account the type of autonomic regulation of the heart rate according to N.I. Shlyk (2021).

Organization of the study

The assessment of the activity of various structures of the brain was carried out using a 5-channel hardware-software complex for topographic mapping of the electrical activity of the brain "NEURO-KM", scientific medical firm "STATOKIN" (Moscow, Russia). The device shows the level of constant potentials of the brain (LCP), also referred to in the literature as the omega potential. The parameters of energy metabolism were assessed by registering LCP in the frontal (Fz, mV), parietal (Cz, mV), occipital (Oz, mV), right and left temporal (Td, mV, Ts, mV) leads in a state of relative physiological rest. The contribution of metabolic processes and the level of adaptive capabilities were carried out in accordance with the generally accepted LCP ranges according to V.F. Fokin (2014). The experiment involved qualified athletes-sprinters, who were randomly assigned to the experimental (n=26) and control (n=26) groups. EG athletes took ergogenic means in the system of sports training for 21 days: apiproduct "Bilar" and amino acid complex MDX, followed by a course of exposure to low-intensity laser radiation for 7 days on the apparatus "Pattern-A-2K", pulse repetition rate 1500 Hz, exposure for 8 minutes, output power 3.7 W, two emitters per carotid artery area. The CG athletes took a placebo (food starch) and a simulated laser treatment. The research was carried out in a special preparatory stage of the annual cycle.

Research results

In type II sprinters, the combined use of dietary supplements and LILR maximally reduced the level of constant potential by 15-18.3% (p <0.05) in all studied areas (fig. 1).

II тип ВСР

% ◆ после БАДов ■ БАД+НИЛИ

Tdz	Oz	Tsz	Cz	Fz
-5,1	-5,2	-4,9	-4,4	-3,8

-15*
-15,2*
-16,6*
-17,5*
-18,3*

Figure 1. Relative gains of LCP sprinters EG with type II regulation after using the studied extra-training means *p<0.05)

With the transition to type I sprinters, the use of food additives was accompanied by a 17.2% (p<0.05) decrease in the LCP index in the frontal region and by 16.3% (p<0.05) in the occipital regions (figure 2).

With the combined use of dietary supplements and LILR, the oxygenation of cortical neurons continued to increase, which contributed to an increase in pH and a decrease in LCP in the frontal lobe by 24%, in the occipital by 22.6%, in the right temporal lobe by 20.1%, and in the left temporal lobe by 18. 3% and the central region - by 17.7%, in all cases (p<0.05).

In the group of sprinters with type III (figure 3), after the use of food additives, a significant decrease by 16.2-19.3% (p<0.05) in the LCP index was recorded in the central, occipital and left temporal regions. In the remaining zones, only a tendency towards a decrease was found (p>0.05).

With the combined use of these restoration means, the energy potential continues to grow. As a result, the LCP value decreased in the central region by 26.2%, occipital - 24.6%, left temporal - 21.3%, frontal - 17.1%, right temporal - 16.4%, in all cases (p<0.05).

Figure 2. Relative gains of LCP sprinters EG with type I regulation after using the studied extra-training means (*p<0.05)

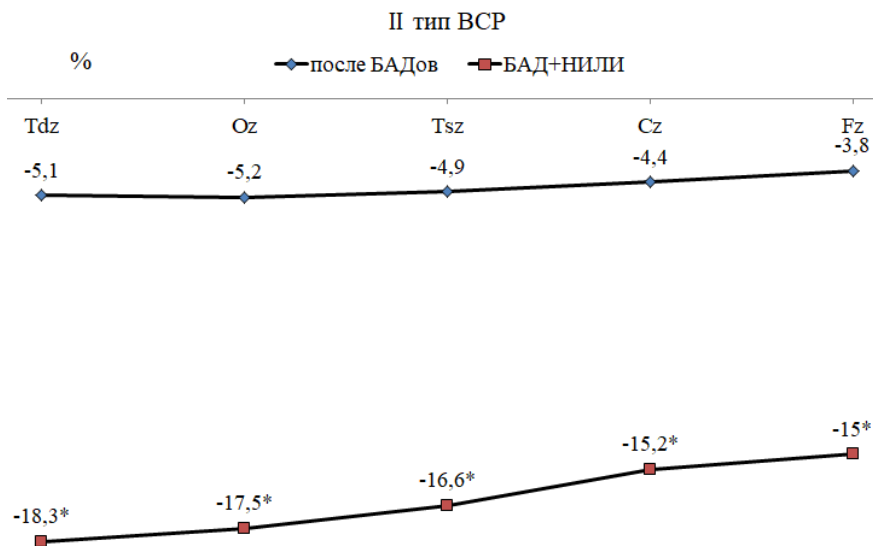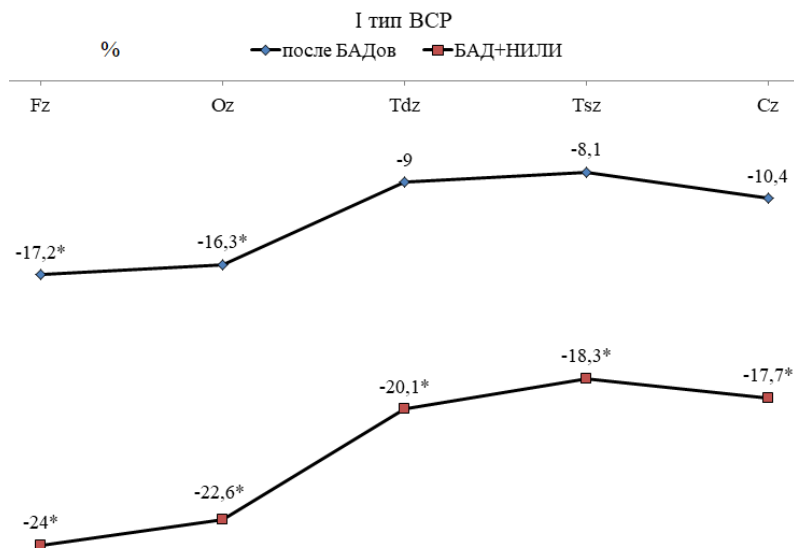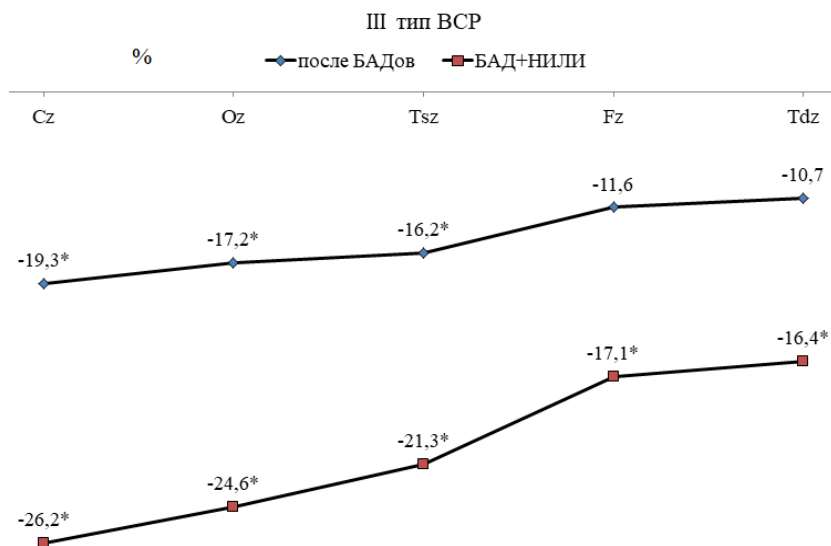**Figure 3. Relative gains of LCP sprinters EG with type III regulation after using the studied extra-training means (*p<0.05)**

A feature of the reaction to supplements of type IV sprinters (figure 4) was a total decrease in the level of constant potential in the frontal region by 19.8%, in the central region - 18.1%, in the occipital region - 17.3%, in the right and left temporal regions - 16. 6-15.1%, respectively, in all cases (p<0.05).

IV тип ВСР

% ◆после БАДов ■БАД+НИЛИ

| Fz | Cz | Oz | Tdz | Tsz |

-19,8*   -18,1*   -17,3*   -16,6*   -15,1*

-24*   -22,1*   -20,3*   -18,3*   -17,6*
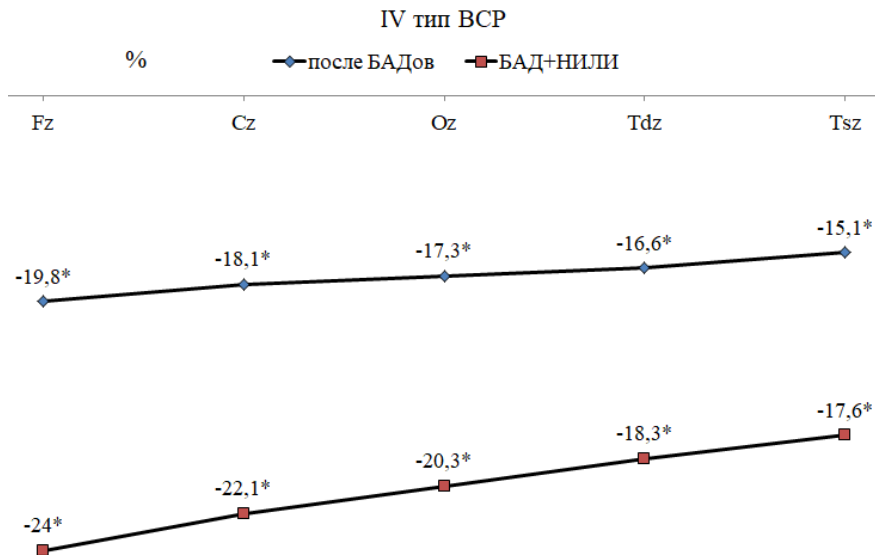
Figure 4. Relative gains of LCP sprinters EG with type IV regulation after using the studied extra-training means (*p<0.05)

With the combined use of LILR and dietary supplements, a significant decrease in the level of constant potential in the studied areas remained: frontal - 24%, central - 22.1%, occipital - 20.3%, right and left temporal 18.3-17.6%, respectively, in in all cases (p <0.05).

Thus, in sprinters, the bioelectrical activity of brain neurons was not the same and depended on the type of autonomic regulation of the heart rate. The different magnitude of the decrease in the LCP index reflected the different level of the sensorimotor response of the studied areas of the cerebral cortex. The efficiency of restoring the energy potential, in turn, depended on the method of using the means of restoring.

In the control group of qualified sprinters, no such dynamics was found, on the contrary, the selected training loads caused an increase in the level of constant potential in all types of autonomic regulation of the heart rate.

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FEATURES OF PRESYNAPTIC INHIBITION IN DIFFERENT TYPES OF MUSCLE CONTRACTION IN IN HUMANS

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Abstract. In the modern literature, there is information devoted mainly to the study of various types of spinal inhibition in the isometric type of contraction. The aim of the study was to study the features of the manifestation of presynaptic inhibition of Ia afferents of the muscle-antagonist of the leg during the implementation of different types of muscle contraction strength in humans. Materials and methods: the study involved 8 men aged 20-21, not involved in physical culture and sports. Presynaptic inhibition was recorded at rest and when concentric, eccentric, isometric contractions were performed at 50% and 100% of the individual maximum. Results: during concentric, eccentric and isometric contractions of different magnitude, the severity of presynaptic inhibition decreased compared to rest. With an increase in the strength of concentric, eccentric, and isometric contractions from 50% to 100% of the individual maximum, the severity of presynaptic inhibition progressively decreased. The greatest severity of presynaptic inhibition was observed with concentric and isometric contractions at 50% and 100% of MVC.

Keywords: presynaptic inhibition, H-reflex, spinal cord, motor neurons, maximum voluntary contraction (MVC), concentric contraction, eccentric contraction, isometric contraction.

The main neuronal mechanisms of coordination and integrative activity are the processes of inhibition in the spinal cord, which have an important functional significance in the regulation of motor activity and locomotor movements [1, 2]. The spinal system of presynaptic inhibition limits the

excessive flow of afferent signals to the nerve centers and has a leading biological significance in the processing of these signals in the central nervous system. This type of inhibition regulates excessive skeletal muscle tone, which prevents the performance of voluntary muscle contraction [2].

In the modern literature there is information devoted mainly to the study of various types of spinal inhibition with isometric type of muscle contraction in people involved in physical culture and sports [3]. The authors found that in the process of isometric contraction, presynaptic inhibition actively regulates the excess afferent influx of muscle agonists and antagonists of the leg to α-motoneurons, disinhibiting non-reciprocal and reciprocal inhibitory influences on them, ensuring normal human motor activity. This article provides data on the features of the manifestation of presynaptic inhibition of Ia afferents during the implementation of different types of muscle contractions in persons not involved in physical culture and sports and the possible mechanisms of these manifestations. New data obtained as a result of this kind of research can become a theoretical basis for studying the physiological patterns of the participation of cortical and spinal neuronal inhibitory networks, which underlie motor tasks of varying complexity in humans.

Material and research methods

Experiment participants

The study involved 8 healthy men aged 20-21, not involved in physical culture and sports. The experiments were carried out in accordance with the Declaration of Helsinki of the World Medical Association.

Method of registration of presynaptic inhibition of homonymous Ia afferents

Conditioning stimulation was used n. peroneus profundus, applied 100 ms before the test stimulus n. tibialis, which made it possible to assess the degree of suppression of the amplitude of the testing H-reflex m. soleus [1, 3] (fig. 1A). It was assumed that the greater the suppression of the amplitude of the testing H-reflex m. soleus with respect to the amplitude of the control H-reflex, the more pronounced presynaptic inhibition. Testing and control stimulation n was carried out using monopolar electrodes (0.9 cm in diameter). tibialis with stimulus intensity 15-25% of the maximum amplitude of the H-response m. soleus. In this case, the active electrode was fixed in the fossa poplitea, and the indifferent one, on the patella. Applying a conditioning stimulus to n. peroneus profundus was performed through monopolar electrodes with an intensity of 5-15% of the maximum M-response m. soleus. The active electrode was located near the outer corner of fossa poplitea, lateral and distal to the electrodes for stimulation

n. tibialis, indifferent - on the patella. On an eight-channel Mini-Electro-myograph with the Muo software (ANPO "Return", St. Petersburg, 2003), the amplitudes of H-reflexes and M-responses were recorded, conditioning stimulation and testing stimulation of afferents Ia were performed, the EMG activity of antagonist muscles was recorded (m. tibialis anterior, m. soleus) [3].

Registration of concentric, eccentric, isometric contractions

In all experiments, the subjects sat comfortably in a chair on the Biodex Multi-Joint System Pro-3 (USA, 2006) multi-articular diagnostic and treatment complex and performed plantar and dorsal flexion in the ankle joint. The angle at the knee joint was 110º, the head was resting on the headrest of the chair, the arms were freely crossed on the abdomen, the shin and knee joint were rigidly fixed, the ankle joint remained mobile, the foot rested on the platform. Subjects performed contractions of 100% and 50% MVC. The range of motion in the ankle joint for both MVCs was 60º (fig. 1B).

Concentric muscle contraction began at an ankle angle of -30° and ended at an angle of + 30°. Eccentric contraction, on the other hand, began at an ankle angle of + 30° and ended at an angle of -30 °. The total duration of each contraction was 2 seconds. Isometric contraction was performed at three articular angles – -30°, 90°, and + 30° (fig. 1B).

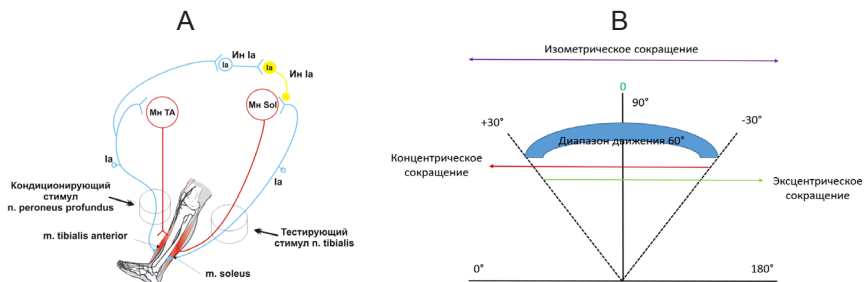**Fig 1. A: Schematic description of the methodology for assessing presynaptic inhibition of afferents Ia m. soleus; B: Scheme of performing concentric, eccentric and isometric contraction of the lower leg muscles**

Presynaptic inhibition was recorded under the following experimental conditions: 1) at rest (REST); 3) when performing concentric, eccentric, isometric contractions of 50% and 100% of the individual maximum.

The Kruskal-Wallis test (Statistica 12.5, USA) analysis of variance was used to assess the significant differences between the indicators under different experimental conditions. Statistical significance was set at P<0.05.

Results and its discussion

As a result of the study, it was found that during the performance of concentric, eccentric and isometric contractions, different in magnitude, the severity of presynaptic inhibition decreased in comparison with relative muscle rest (Fig. 2; P<0,05[*, **, ***]). When registering presynaptic inhibition during the retention of concentric contraction with a force of 50% of MVC, the amplitude of the testing H-reflex increased by 66.73% (P<0,05[*]; fig. 2), and with an effort of 100% of MVC - by 136.73% (P<0,05[*]; fig. 2) in comparison with rest; eccentric contraction with a force of 50% of MVC - by 91.09% (P<0,05[**]; fig. 2) and with an effort of 100% of MVC - by 177.24% (P<0,05[**]; fig. 2); isometric contraction with a force of 50% of MVC - by 61.85% (P<0,05[***]; fig. 2) and with an effort of 100% of MVC - by 124.52% (P<0,05[***]; fig. 2). It is assumed that the weakening of this type of inhibition is associated with excitatory and inhibitory corticospinal influences on Ia interneurons of presynaptic inhibition. In particular, studies using transcranial magnetic stimulation of the motor zones of the cerebral cortex and cerebellum in humans have shown that modulation of presynaptic and reciprocal inhibition occurs via cortico-, reticulo- and vestibulospinal pathways to homonymous α-motor neurons of the spinal cord [4].

With an increase in the strength of concentric, eccentric and isometric contractions of skeletal muscles from 50% to 100% of the individual maximum, the severity of presynaptic inhibition progressively decreased (fig. 2; P<0.05 ##).

Comparative analysis of the severity of presynaptic inhibition with different types of contraction showed that its greatest manifestation was observed when concentric and isometric contractions were performed at 50% and 100% of MVC (fig. 2; P<0,05[§]) compared with eccentric contractions.
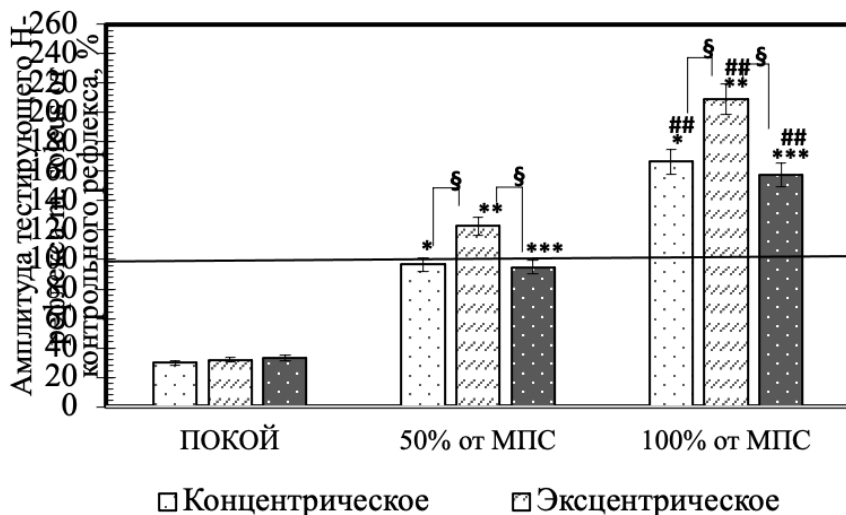
Figure 2. Amplitude of the testing H-reflex m. soleus from the control reflex in a state of relative muscle rest and when performing concentric, eccentric and isometric contractions,%

Note: *, **, ** – reliability of differences in indicators for different types of muscle contraction in 50% of MVC and 100% of the individual maximum in relation to the state of relative muscle rest; ## - reliability of differences in indicators of different types of muscle contraction in 50% of MVC in relation to 100% of the individual maximum; § - reliability of differences in the severity of presynaptic inhibition with different types of muscle contraction in 50% of MVC and 100% of the individual maximum (Kruskal-Wallis Anova).

To explain our results, let us consider the main putative spinal and supraspinal mechanisms involved in the regulation of concentric, eccentric and isometric contractions (fig. 3). Presynaptic inhibitory mechanisms can reduce the excitability of the spinal cord motoneuron pool in different types of contraction. Presynaptic inhibition can be caused by two mechanisms: homosynaptic postactivation depression caused by a decrease in the release of neurotransmitters at Ia interneurons and primary afferent depolarization (PAD) through inhibitory interneurons Ia. The latter mechanism is centrally regulated and modulated during muscle activity (Fig. 3).

Experimental data indicate that postsynaptic inhibitory mechanisms can also affect the excitability of spinal cord motor neurons in different types of muscle contraction. Non-reciprocal inhibition or inhibition of Ib

(Golgi tendon organs), reciprocal inhibition and recurrent inhibition (Renshaw cells) are involved in the regulation of muscle activity (fig. 3). Golgi tendon organs contribute (non-reciprocal inhibition) to modulation of spinal excitability through Ib interneurons with weak and strong muscular efforts [5]. Reciprocal and non-reciprocal inhibition in the process of isometric contraction manifest themselves as weakening and are under the control of presynaptic inhibition, which actively regulates the excessive afferent influx of muscle agonists and antagonists of the leg to α-motor neurons [3].
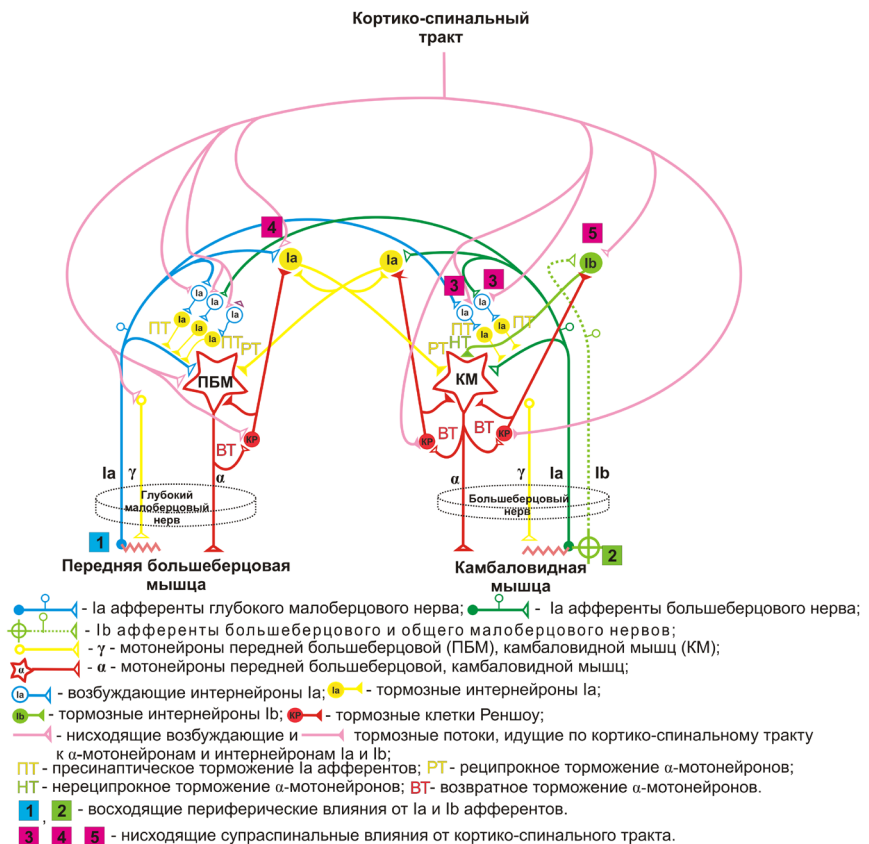

Figure 3. A putative scheme of the inhibitory interneuronal network of the leg antagonist muscles (the anterior tibial and soleus muscles), mediated by ascending and descending influences on spinal motoneurons in the regulation of different types of muscle contraction

Excitability of α-motoneurons of the spinal cord can be modulated through Renshaw cells - rebound inhibition (fig. 3). When phasic and strong tonic contraction of the leg muscles is performed, low activity of return inhibition of homonymous human α-motor neurons is shown [2].

The implementation of voluntary movements is carried out by descending supraspinal influences from the corticospinal tract, which has excitatory inputs to interneurons Ia of reciprocal and presynaptic inhibition, Renshaw inhibitory cells of reentrant inhibition of α-motoneurons of the antagonist muscle (anterior tibial), as well as inhibitory inputs to interneurons Ia of non-interneurons reciprocal and presynaptic inhibition, Renshaw's inhibitory cells of the reentrant inhibition of α-motor neurons of the agonist muscle (soleus) (fig. 3) [1, 3].

Thus, we can conclude that the manifestation of presynaptic inhibition of Ia afferents of the flexor muscle of the foot depends on the type and strength of muscle contraction and is in close interaction with afferentation from proprioceptors and supraspinal descending influences.

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OZONE DELIGNIFICATION OF HARDWOOD. OPTIMIZATION BASED ON THERMAL ANALYSIS AND RAMAN SPECTROSCOPY DATA

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Abstract. Transformations of aspen wood under the ozone treatment were investigated by means of Raman spectroscopy and thermal (TG/DTG) analysis. TG/DTG curves of lignocellulose materials (LCM) obtained at different values of specific ozone absorption were analyzed. Modeling of DTG curves by Gaussian components was carried out. It is shown that under the ozonation of wood, the content of hemicellulose (HC) and lignin (LG) decreases, the cellulose content increases. Raman spectra indicate the destruction of aromatic structures of LG as the amount of specific ozone consumption increases. Degradation of the cellulose structure at high ozone consumption was noted. The paper establishes the optimal range of ozone treatment corresponding to the predominant destruction of LG and HC.

Keywords: ozone, wood, delignification, thermal analysis, Raman spectra

Among the products of biomass conversion, cellulose (CL) and derivative compounds are most in demand. Plant cell walls consist of cellulose fibers incorporated into a matrix of hemicelluloses (HCs) and lignin (LG) that are linked to each other covalently [1,2]. This feature of plant biomass structure limits the availability of cellulose fiber for the reagents necessary for the subsequent isolation of CL, and prevents the successful bioconversion of CL into sugars [1-3]. Increasing the availability of cellulose fiber is therefore associated with pretreatment based on the delignification of biomass.

The use of ozone for the oxidative destruction of LG is due to high rate constant of interaction with such phenolic compounds as LG, and its

much lower rate constant of interaction with carbohydrates [2-5]. The most important parameter in ozonation of biomass is the water content [4,6-9]. The optimum water content for ozone delignification differs for different types of biomasses. Studies on the kinetic patterns of ozone absorption have shown that a water content of 55–60% is best for the ozone treatment of aspen wood. In this case delignification degree of the biomass achieves 60-70%. [7],

Materials obtained by treating biomass with ozone were studied by a lot of methods, namely UV, IR, Raman spectroscopy, X-ray diffraction, and electron microscopy. The content of lignin in ozonated samples was determined. [6-10]. HPLC was used to examine the water-soluble products of biomass ozonation [9,10]. Ozonated LCMs were tested in reactions of the enzymatic hydrolysis of sugars [8]. In [11-13] thermal analysis was used to study the transformations of LCM during ozone treatment. It was established [13, 15] that a decrease in the thermal stability of the LCM is due to a decrease in the content of LG, and according to [14] a decrease in the content of crystalline CL also acts similarly. TG/DTG analysis showed that the delignification of pine wood with ozone is accompanied by the destruction of hemicelluloses [12, 13].

The aim of this work is to study the transformations of aspen wood at various stages of ozonation and to determine the optimal conditions of ozone treatment in relation to biomass delignification. To solve this problem, samples of LCM obtained at different values of specific ozone consumption were investigated by the thermal analysis. Modeling of DTG curves by Gaussian components was carried out. LCM samples are characterized by Raman spectra.

Experimental

We studied sawdust of aspen wood (*Populus tremula*), particle sizes fraction of ≤ 0.315 mm. The moisture content in the samples was 55-60% (MC, % = ($m_{H2O /m o.d.w.}$) × 100), where o.d.w. is oven-dried wood). Preliminary preparation of samples is described in [9].

Ozonation was carried out in a flow system with a fixed-bed reactor at an ozone concentration of 50-60 mg/l and a flow rate of 4 l/h. The amount of ozone absorbed per gram o.d.w. (Qr, mmol/g) with different processing time of the sample is determined according to [7,9]. After ozone treatment, the LCM samples were washed with water to remove soluble ozonation products and then were air-dried.

Raman spectra were recorded on a Bruker Equinox 55/S instrument with an FRA 106/S attachment. The wavelength of the excitation 1064 nm, the laser power was 1400 mW, and the spot size was 0.1 mm. Spectra

were recorded from four different randomly selected sampling points. The experimental Raman spectra were normalized to the band at 1096 cm^{-1}, and the average intensities of different bands in the Raman spectrum were determined.

NETZSCH STA 449 C Jupiter instrument was used for thermal analysis of the samples. Wood samples were analyzed at a heating rate of 10 K/min in the range of 40 °C to 600 °C in an argon atmosphere, a gas flow rate of 80 mL/min and sample weights of 5–7 mg.

Deconvolution of DTG curves into Gaussian components was carried out using the OPUS 6.0 (Bruker) software according to the Levenberg-Marquardt algorithm. The mean square approximation error was no more than 0.05 %/min [13].

Results and discussion

Absorption of Ozone by Wood

Figure 1 shows the kinetic curves of ozone absorption by wood samples of moisture content 55-60% and different time of ozone treatment. Figure 1 presents a kinetic profile of ozone absorption, and the dots in the figure indicate Qr values corresponding to the end of ozone treatment.
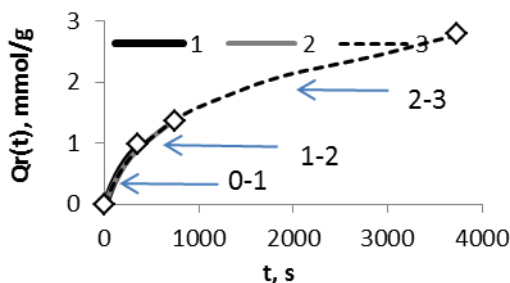
Fig. 1. Kinetic curves of specific absorption of ozone by aspen wood. Ozonation time, s: ▬▬ 360, ▬▬ 720, ▬▬▬ 3700

At the first stage (0-1), 1.0 mmol O$_3$/g was absorbed for 360 s (curve 1); 720 s (curve 2) was required for absorption of 1.4 mmol O$_3$/g, and for 3700 s 2.8 mmol O$_3$/g (curve 3) was absorbed. The different rate of ozone absorption, characteristic of the selected areas, indicates the course of various processes. The following is an analysis of the samples corresponding to the dots in Fig. 1.

Raman spectra

Figure 2 shows the Raman spectra of the wood samples. The spectrum

of the initial sample (No. 1) contains bands at 1600 cm⁻¹ (stretching vibrations of C–C in the guaiacyl ring) and 1662 cm⁻¹ (v_C=O in conjugated aryl ketones [15,17]). The intensity of these bands falls notably for ozonized samples. Table 1 shows average values of the ratio of the band intensities ($I_v/I^0{}_v$) of ozonized (I_v) and initial sample ($I^0{}_v$).
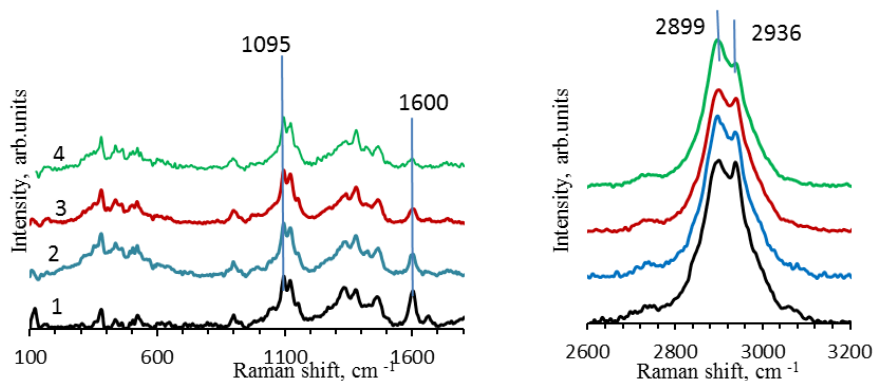
Fig.2. Raman spectra of ozonized wood. Qr,mmol/g: 0(1), 1,0 (2), 1,5 (3), 2,8 (4).

An estimation of the fraction of the destroyed aromatics (LG*) shows that in sample No3 (Qr 1.5 mmol/g), 37% of the aromatic structures of the original sample are remained in the sample after ozonation, therefore 63% of them were destroyed by ozone. These data indicate the delignification of the biomaterial. About twice increase of ozone consumption (sample No 4) results in 5% additional increase of LG* value. These data show that lignin removal take place predominantly at the first stages of ozonation.

For ozonized samples, the bands at 2899 and 2936 cm⁻¹ change in concert since they are superimposed on one another. The bands at 2936 cm⁻¹ (C-H stretching vibrations of aliphatic groups in CH_3 and OCH_3 groups of LG and HC), and 2899 cm⁻¹ (C-H stretching vibrations of cellulose), decrease slightly for ozonized samples.

Ratio of band intensities (I_v/I^0_v) in the Raman spectra of ozonized (I_v) and initial wood (I^0_v) and the fraction of ozone-oxidized lignin (LG*) (%) in wood samples

Sample No	Qr,mmol/g	I_{1600}/I^0_{1600}	I_{2899}/I^0_{2899}	I_{2936}/I^0_{2936}	LG*, %
1	-	1.0	1.0	1.0	0
2	1.0	0.42	0.98	0.98	58±
3	1.5	0.37	0.93	0.83	63±
4	2.8	0.32	0.92	0.75	68±

Thermal analysis

Figure 3 shows the TG/DTG curves of the studied samples, and Table 2 shows the results of TG/DTG analysis. As it is shown in the TG curve in Fig. 3 for a sample of initial wood (curve *1*), in the interval 40−130°C (interval I), the mass loss ($-\Delta m$) is 1.9%.

Figure 3. TG (A), and DTG (B) curves of aspen wood samples. Qr, mmol/g: 0 (1), 1,5 (2),2,8 (3).
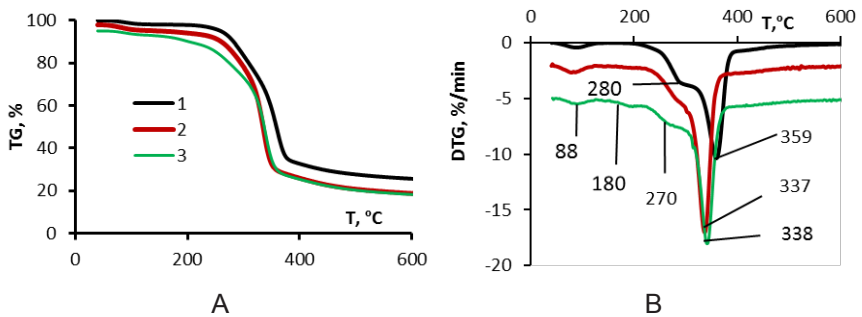
In the second interval (130–600°C) $-\Delta m$ = 71.7%, the residual mass is 25.6%. A comparison of the values of $-\Delta m$ and m_{res} shows that as the specific absorption of ozone increases, the mass loss in the indicated temperature range increases (samples No 2, No 3), and the residual mass decreases, respectively.

Mass loss (–Δm) in two temperature ranges, residual mass (m $_{res}$), temperatures of maximum rate of mass loss (Tmax) for LCM samples nos. 1–4, obtained at various values of specific ozone consumption (Qr)

No	Qr, mmol/g	-Δm, %		m $_{res}$,%	T$_{1max}$,°C	T$_{2max}$,°C
		40−130 ºC	130−600 ºC			
1	0	1.9	72.5	25,6	88	359
2	1.0	2.4	74,9	22,7	89	341
3	1.4	2.8	76,4	20,7	84	337
4	2.8	2.0	74,8	23,2	89	338

For sample No 4, the values –Δm and m_{res} almost coincide with those obtained for sample No 2. For ozonized samples, the position of the maximum on the DTG curves shifts to lower temperatures, in the second temperature range the rate of mass loss increases (Table 2, Fig. 3). Obviously, the observed changes in the TG/DTG data are due to changes in the LCM composition depending on Qr.

Thermal destruction of wood is usually represented as the sum of reactions of thermal decomposition of individual components, HCs, CL, and LG [18, 19]. It is known that the intervals of thermal destruction of HCs, CL, and LG overlap, hemicelluloses are destroyed at 225–325°C, cellulose has the range 305– 375°C, and the thermal destruction of lignin occurs in a wide range from 150 to 500°C [18,19]. Therefore, the data presented do not allow us to assess the contribution of these structural components of biomass to mass loss under pyrolysis conditions. In [14, 19], to solve this problem, simulation of DTG biomass curves using individual Gaussian components was proposed.

To describe the dynamics of HCs, CL, and LG destruction by ozone in the wood structure, we used a mathematical model based on the modeling DTG curves by symmetric components of a Gaussian profile; the integral intensity (area under the curve) of each decomposition component and its contribution to the total integral intensity of the model curve DTG (Ar) were determined. The integral intensity of individual component corresponds to the relative mass loss due to a given individual process. The results of simulation of DTG curves for the initial wood and ozonized LCM are shown in Fig. 4.

A comparison of the experimental values of mass loss (–Δm) in Table 2 with the values of the total integral intensity of the model curve DTG

(*Ar*), shows that for all samples the error of simulation is in the range of 2.5–4.5%. In Fig. 4A, the DTG curve of the initial sample is represented by a model of eight symmetric Gaussian components. The band at 294°C belongs to hemicelluloses, which consist mainly of xylan [18, 20] in hardwood and are characterized by low thermal stability [18]. The thermal destruction of cellulose is characterized by two components #5 at 347°C and #6 at 361°C, which can be attributed to CL with varying degrees of crystallinity, CL_{c1} and CL_{c2}, correspondingly [23]. LG is represented by a wide band with a maximum at 335°C. Component #2 refers to impurities and high temperature components #7,#8, which can be attributed to aliphatic and aromatic carbon in coals formed during the thermal destruction of biomass. According to the proposed approach, the contribution of the component is considered as an equivalent to the mass loss of the structure to which this component of the model is assigned.

Within the proposed approach, for initial sample Ar_c/Ar of LG is 25.7% of the area of all decomposition components corresponds to the same fraction of LG in the mass loss. Within the proposed approach, for initial sample Ar_c/Ar of LG is 25.7% of the area of all decomposition components corresponds to the same fraction of LG in the mass loss (Fig.5).
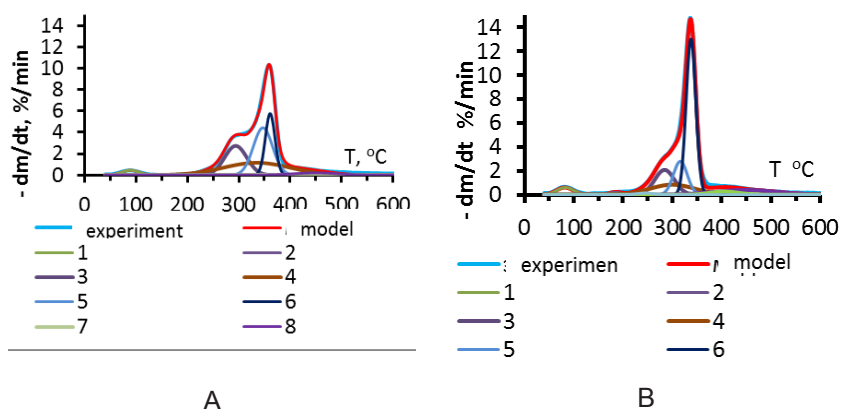

Figure 4. Modeling of DTG curves with Gaussian components. Initial sample (A), ozonized sample (Qr 1.5 mmol/g).(B)
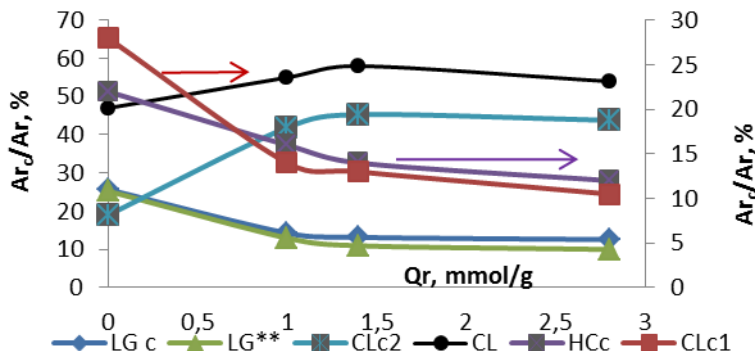
Figure 5. Component contribution (Ar$_c$/Ar) to the total area of wood samples DTG at different ozone consumption (Qr)

The contribution of HCs to the mass loss is 22.3%, and the fraction of CL, represented by the sum of the two model components (CL$_{c1}$ and CL$_{c2}$), is 47.0%. These values correlate with the composition of deciduous wood (46–48% CL, 19–28% LG, 26–35% HCs [18, 21]). The integral intensity of the Gaussian component with a maximum of 88°C is 1.9%, that, as expected, coincides with the value of the mass loss in the I temperature range, referring to physically adsorbed water. For ozonized LCM, the position of the maximum T_{1max} in Table 1) practically does not change, and the intensity of the only Gaussian component in this interval agrees with the value of -Δ_m in Table 2. For ozonized samples, the maximum of the experimental curves DTG (T_{2max}) shifts to the region of lower temperatures (Table 2). In [13, 15], the decrease in the thermal stability of For ozonized samples, the maximum of the experimental curves DTG (T_{2max}) shifts to the region of lower temperatures (Table 2). In [13, 15], the decrease in the thermal stability of ozonized samples is associated with a decrease in the content of LG (the most thermally stable component of biomass). In this work, the contribution of LGc decreases with Qr increasing.

As seen in Fig.5, the dependence of LGc, in principle, correlates with the change in the content of LG in ozonized aspen wood, determined earlier for a similar series of experiments [7]. The simulation results are also consistent with a decrease in the intensity of the bands of aromatics in the Raman spectra.

In ozonized samples, the fraction of HC$_c$ components, as well as LG$_c$, decreases noticeable. The components #5,# 6, referring to CL, in ozonized samples have maxima at 316–318°C and 337–341°C, and the total contri-

bution of CL in ozonized samples increases in comparison with the initial sample. The value of Ar_c/Ar of the low-temperature component CL_{c1} for ozonized samples changes depending on Qr (Fig.5), and the contribution of the component #6, related to the thermally more stable CL, is close to 44% and practically does not change in the Qr range above ~1,5 mmol/g.

At Qr 1.5 mmol/g, the contribution of the low- temperature component CL_{c1} has maximum value (13.9%), at Qr 2.8 mmol/g, the value of CL_{c1} decreases. This result indicates partial destruction of cellulose during ozonation. For sample No 4, the total contribution of cellulose (CL_{c1} + CL_{c2}) is 54.4%, and for sample No 3 at (Qr 1.5 mmol/g) its amount reaches maximum (58.1%). A comparison of these values with the data of the CL content in LCM from ozonized aspen wood (from 50 to 65% depending on Qr [6]) indicates that the data of simulation are close to the real values for the composition of ozonized LCM. The results of the work show that, despite the relative selectivity of ozone with respect to aromatic groups, ozone treatment leads to the degradation of the entire structure of LCM. Nevertheless, different regions of Qr can be distinguished in the ozone absorption profile in Fig. 1, the initial linear segment (*0–1*) is the region of predominant destruction of LG and HCs. In the Qr range (*1–2*), the destruction of LG and HCs in the biomaterial continues. The maximum content of CL in the ozonized material is reached. The long section (*2–3*) is the range where the reactions of ozone with various ozonation products of LCM take place, and the cellulose is partially destroyed.

Thus, the range of the specific consumption of ozone, which is optimal for the delignification of wood, was determined, and the advantage of shorten treatment of the biomaterial with ozone to obtain a material with high content of cellulose was shown using the thermal analysis and Raman spectra.

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DEVELOPMENT OF CONFECTIONERY GLAZE OF INCREASED NUTRITIONAL VALUE

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Abstract. To improve the appearance and increase the shelf life of confectionery products, various types of glazes are used. In recent years, confectionery glazes made on cocoa butter substitute fats have been widely used. Glazes are characterized by a limited nutritional value with a high energy intensity. The aim of this work was to increase the nutritional value of the fat glaze with the introduction of black currant powder. This goal was achieved by studying the effect of currant powder on the quality of the glaze and establishing the possible range of its use.

Keywords: confectionery glaze, nutritional value, currant powder.

Various types of glazes are widely used in the confectionery industry. They are used for enrobing confectionery products in order to improve the appearance and increase the shelf life [3]. One of the types is confectionery glaze. It is characterized by a limited nutritional value with a high energy content. Considering that the content of glaze in confectionery products can be from 10% to 30%, it seems relevant to increase its nutritional value due to the introduction of herbal supplements containing functional ingredients.

The purpose of this work was to increase the nutritional value of confectionery glaze by using blackcurrant powder. This goal was realized by solving the following tasks: to substantiate currant powder as an enrichment agent for glazes; to study the effect of dosage of currant powder on the quality of the glaze; to conduct a comparative assessment of the nutritional and energy value of the new glaze in comparison with the traditional one.

The confectionery glaze was made according to the traditional technology [5].

As a base, we used a glaze made according to the recipe shown in table 1.

Table 1.
Recipe, Fat confectionery glaze

Name of raw materials	Mass fraction of dry substances, %	Total consumption of raw materials per 1 ton, kg	
		hydrated	in dry matter
Powdered sugar	99.85	528.20	527.4
Skimmed milk powder	95.0	154.60	146.87
Non-lauric type cocoa butter substitute	99.7	324.20	323.22
Vanillin	-	0.55	-
Lecithin	98.5	4.0	3.94
Total:	-	1011.00	1001.43
Yield:	99.0	1000.0	990.0

The composition of blackcurrant powder is shown in table 2.

It is known that the berry - currant has long been famous for its useful properties, it is the record holder for the content of vitamin C [4]. Powder from currant berries contains a large amount of dietary fiber - 21 g per 100 g of product, predetermining the physiological value of the product [2].

The preparation of a powder from berries obtained by freeze drying, which has become widespread in recent years, ensures the safety of all, without exception, the beneficial properties and organoleptic characteristics of the products. This method perfectly preserves vegetables, fruits, berries [4].

The calorie content of currant powder is 254 kcal per 100 g of product.

Currant powder was added to the glaze, at the conching stage, in an amount of 5, 10, 15, 20% to the weight of the powdered sugar in the recipe. In the glaze samples, organoleptic and physicochemical indicators were determined.

Table 2.
Blackcurrant powder composition [1]

Nutrients, vitamins, trace elements (per 100 g of product)	
Proteins, g	7.5
Fat, g	-
Carbohydrates, g	55.6
Mono- and disaccharides, g	53.5
Total dietary fiber, g	21.0
Ash, g	7.8
Vitamins, mg	
A	6.263
B1	0.078
B2	0.098
B6	0.317
PP	1.542
C	71.521
E	7.354
Mineral substances, mg	
Potassium	201.5
Calcium	47.84
Phosphorus	43.65
Magnesium	37.61
Sodium	20.4
Iron	6.2

As a result of the research carried out, the following was established:

- the glaze with the addition of powder in an amount of up to 10% had a uniform consistency, pleasant color, original taste and aroma. An increase in the added additive led to the formation of a glaze with a non-uniform consistency.

The introduction of powder into the glaze from 5% to 20% led to an increase in the mass fraction of moisture in it from 1.65% to 2.1%. The mass fraction of moisture in the control was 1.5%.

The addition of blackcurrant powder to the glaze increased the viscosity of the glaze. It was found that the use of a powder in an amount of 20% increases its viscosity by almost 2 times, which negatively affects its quality.

As a result, the area of rational use of currant powder in the production of fatty glaze was determined from 5% to 10% to the weight of powdered sugar according to the recipe, and a new recipe for currant glaze was developed.

The energy intensity of the new glaze, in comparison with the traditional one, is slightly reduced - by 4%, while the content of dietary fiber has increased by 5.4 times, magnesium by 120 times, potassium by 8.2 times, phosphorus by 4.4 times. The content of vitamin B1 increased 1.8 times, vitamin B2 - 2.2 times, vitamin PP - 3.8 times.

The competitiveness of the developed glaze "Currant" is confirmed by the increased nutritional value, as well as the original color, taste and aroma.

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EXPERT PROGRAMMING TECHNOLOGY

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Annotation. With the digitalization of industry, the integration of the Internet of things and the Internet of knowledge is taking place. This article describes the technology for creating knowledge bases by non-programmers.
Keywords: artificial intelligence, Industry 4.0, Industry 5.0, digital manufacturing, intelligent systems, intelligent design and management systems.

With the object-oriented approach to the design of software systems, there are two relatively independent and at the same time closely inter-related sides of modeling: static and dynamic. Static modeling defines the structure of classes and objects, while dynamic modeling defines their behavior. When developing intelligent design systems using modified UML, class and object diagrams are used for static modeling. However, the UML lacks the object-oriented dynamic modeling tools needed to build intelligent systems.

A sharp increase in the number of specialists capable of developing software can be achieved by attracting knowledge holders in applied fields who do not know programming. This task belongs to the competence of another field of informatics - artificial intelligence (AI).

A sharp increase in the number of specialists capable of developing software can be achieved by attracting knowledge holders in applied fields who do not know programming. This task belongs to the competence of another field of informatics - artificial intelligence (AI).

Unfortunately, in practical terms, artificial intelligence technologies do not provide a solution to the problem in full accordance with the above definition.

The advent of algorithmic languages supporting procedural programming technology has taken the computer science industry to a higher level. There were a number of stages in the development of procedural program-

ming, the most important of which should be attributed to the technologies of structured and modular programming. Some fundamental provisions of these technologies were taken into account in expert programming, which, however, does not belong to the class of procedural programming.

In structured programming, the fundamental is the structuring theorem, which proves that any simple program is functionally equivalent to a structured program composed of elements of the basic set {sequence, ifthenelse, whiledo}. This means that any program that is one functional unit can be composed of structures of three basic types.

A useful structural programming recommendation in practical terms is the expediency of decomposing complex systems into parts containing no more than 40-50 components. The next fundamentally important step in the development of technology was the transition to object-oriented programming (OOP). This step, which can be likened to the transition to machine-made material products, allows the development of high-quality software of increased complexity through better data sharing mechanisms, increased code repeatability, the use of standardized user interfaces, and so on.

In addition to the graphical representation of the multi-agent system of the above, it is advisable to have an equivalent textual one. Below is a textual representation of the module for calculating the gear ratio for the gearbox. Such a representation, which will be used in the future, is automatically generated by the documentary of the expert programming system.

NM: "PR3" - Calculation of the gear ratio
Launch preconditions

Name	Description	Type	Value
VidSE nt	Assembly Unit Type Output speed, rpm	STRING REAL	Reducer (0,)

Input properties

Name	Description	Type	Value
nh	Input rotation frequency, rpm	REAL	
nt	Output speed, rpm	REAL	

Mechanism – Formula

Urz = nh/nt

Output properties

Name	Description	Type	Value
Urz	Передаточное число	REAL	
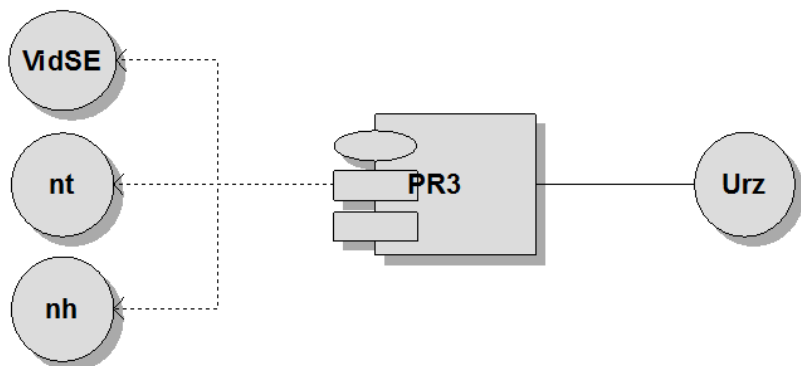
Figure 1. Graphical representation

Using the MV type of formulas, you can form text variables. Text constants are enclosed in quotation marks, for example "Mill wheel rim m =". Numeric variables are converted to text using the Str () function. The individual components of the text are connected using the + sign. If variable $m = 1$, and $z\_ = 33$, then the module below will generate the following text: "Mill wheel rim m = 1, z = 33 finally".

NM: "FrSdPrC3" - Shaping the content of the finishing transition
Launch preconditions

Name	Description	Type	Value
ViZubKol$	Cogwheel type	STRING	cylindrical, conical
n_	Number of simultaneously processed parts	INTEGER	1
HarObr$	The nature of the processing	STRING	Rough
StToch	Степень точности	INTEGER	10, 9

Input properties

Name	Description	Type	Value
m_	Part module, mm	REAL	
z_	Number of teeth	INTEGER	
nt	Output speed, rpm REAL		

Mechanism
SodPer$ = " Milling wheel rim m"+Str(m_)+", z = "+
    Str(z_)+" finally"

Output properties

Name	Description	Type	3 Value
SodPer$	Transition content	STRING	

KM: "Faska" - Chamfer size selection

Input properties

Name	Description	Type	Value
D_	Cap diameter, mm	REAL	112

Mechanism - Table

Configuration of properties in the table

D_
R_
b_

Table

[10,50]	(50,100]	(100,)
1	1.6	2
3	5	8

Output properties

Name	Description	Type	Value
R_	Chamfer radius	REAL	2
b_	Groove width	REAL	8

KM: "Table" – Selection of dimensions by diameter

Input properties

Name	Description	Type	Value
D_	Diameter of contact with the housing	REAL	50

Mechanism - Table
Configuration of properties in the table

D_
delta

Table

[50,62]	[63,95]	[100,145]	[150,220]
5	6	7	8

Output properties

Name	Description	Type	Value
delta	Cap thickness	REAL	5

The table attached to the module can have a header and a sidebar, which in general can be multilevel. Here, the header at the top level contains the values of the symbolic variable "Replace fixture", and at the bottom - the ranges of "Part modulus, mm". The sidewall also has two tiers: on the upper value of the variable "Setup character", and on the lower value - the variable "Type of feed of the modular worm cutter". Based on these two inputs, the table allows you to determine the values of the output variable scalculation by formulas (including assigning values to variables
  • defining values from tables
  • fetching values from databases
  • updating values in databases
  • entering values into databases
  • calculating values using subroutines
  • calculating values using methods generated from knowledge modules
  • calculating values using methods generated from knowledge modules, generated by other systems.

To provide the ability to generate 3D models using knowledge bases, it is necessary to create a knowledge module that has a mechanism with which, on the basis of a part and (or) assembly unit parameterized in a CAD system, it would be possible to generate a 3D model of a product with dimensions calculated in other modules ...

The constructed 3D model must be connected to the knowledge base through a specialized knowledge module. The interface of the 3D model generation module in the Sprut ExPro system is presented below.
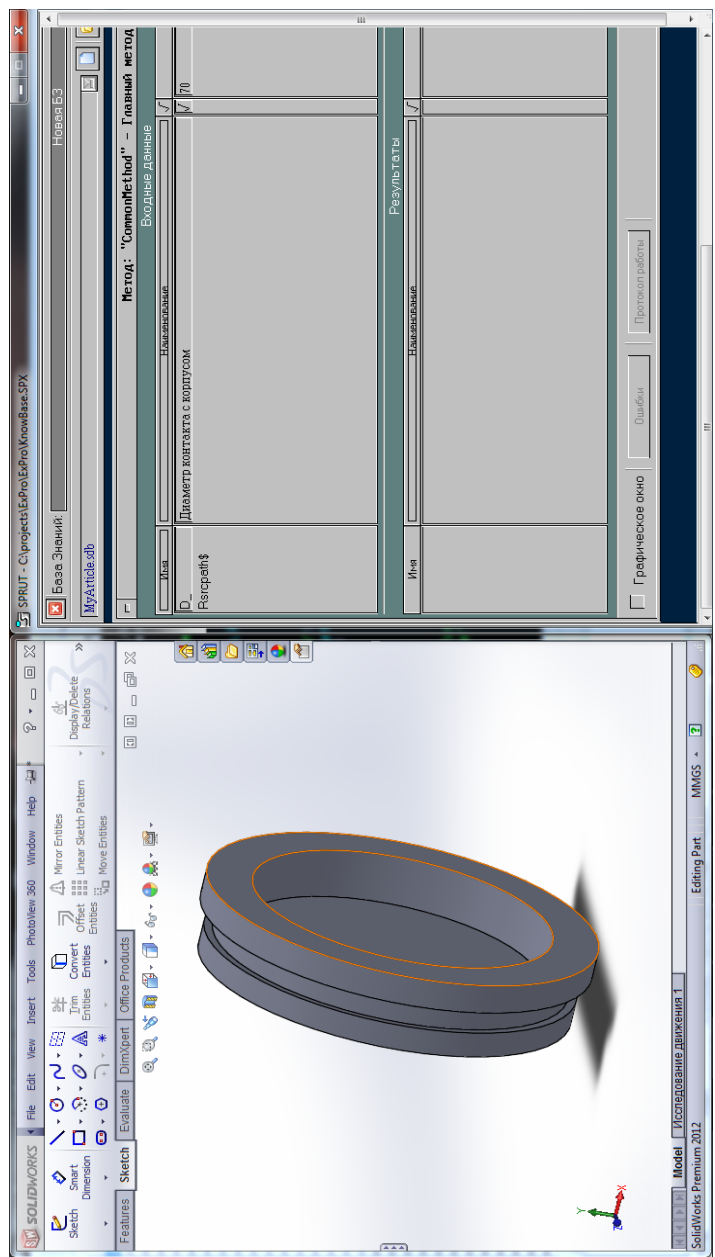
Figure 2. Sprut ExPro interface

To generate a 3D model of the "bearing cap" part, it is enough to set one parameter "Bearing diameter

To generate a 3D model of the "bearing cap" part, it is enough to set one parameter "Bearing diameter

The knowledge base structure model can be represented as a semantic network of interconnected engineering knowledge modules. The named nodes of this network are the modules themselves, and the oriented edges are the input and output variables, the names of which are contained in the dictionary.

The semantic network MV is an acyclic directed graph. Acyclicity is necessary for the semantic network to fulfill its functional purpose s
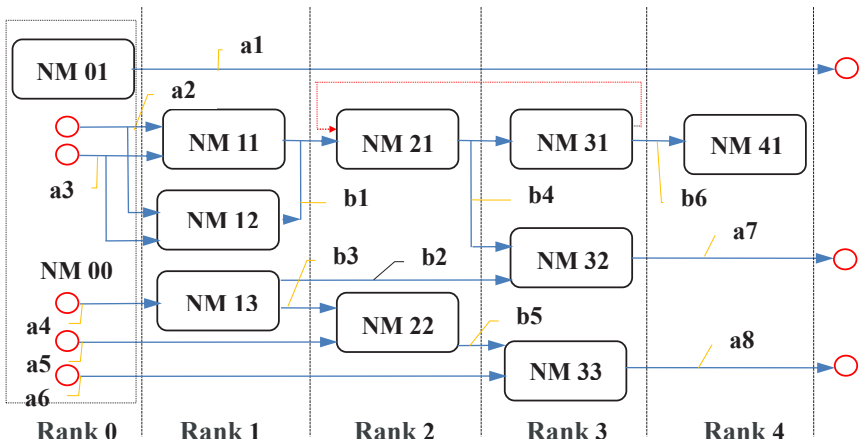
Figure 3. Semantic Web

Due to acyclicity, the entire set of MVs can be split into a strictly ordered (ranked) set of subsets.

When using the technology of expert programming, the process of forming the MV, their translation with obtaining object or executable modules in one of the traditional languages, and testing are performed as one operation. After obtaining the required set of KMs, a method is generated that uses a subset of the generated knowledge modules. The method is generated using the same language as the MV and is a compiled implementation of the solver for a given set of MVs. The compiled production rule selection engine (V) uses a Petri net-like control scheme. The Planning and Conflict Resolution (R) process uses the trigger conditions for

the LH. The program module corresponding to the MV is executed if the values of all input and control variables are present and the condition for its application is satisfied.

The generated method can be used as a knowledge module engine, allowing a hierarchy of rules to be used.

In order for the generated methods, according to the structuring theorem, to solve any programming problem, they must implement three basic structures: succession, alternative, and one of the loops. In expert programming, the following of the MV is determined by the sequence of calculating the variables, and the alternative is determined by the conditions laid down in the MV. For the formation of loops, a dedicated variable "end of loop" (Fincalc) is introduced, when it appears, the system generates a cyclic method that is executed until Fincalc, which is previously assigned to 0, does not take the value 1. One method can contain only one loop. The body of the cycle includes modules of ranks 1 or more. Modules of rank 0 provide initial settings for the values of variables and are not executed in the loop. The possibility of using methods as mechanisms of the MV allows you to obtain both sequences of loops and programs with nested loops.

Based on the foregoing, it can be concluded that the expert programming technology integrates the methods of production systems and semantic networks. At the same time, the ranked semantic network of knowledge modules in the aggregate is a knowledge module, which can be considered as a frame, which is the third basic method for representing knowledge. A frame in knowledge engineering is a structure containing a description of an object in the form of attributes and their values.

So, expert programming integrates all the basic methods of knowledge representation.

The fourth industrial revolution (4PR) is currently taking place in the world. The foundation for 4PR is the Internet of Things. However, 4PR should cover the automation of absolutely all stages and processes, including digital design of a product, creating a virtual copy of it, joint work of design engineers and technologists in a single digital space, etc. That is, the revolution should cover the stages when products are not yet things, but exist in the virtual world in the

To integrate the industrial and digital revolutions, it is necessary to consider in aggregate two worlds: the virtual world, implemented by the Internet of knowledge, and the real world, implemented by the Internet of things. It is advisable to build the Internet of knowledge on an ontological methodology.

The most widespread computer encyclopedia at present is Wikipedia.

Wikipedia is a publicly available multilingual universal Internet encyclope-dia with free content. Its conceptual principles are multilingualism and the ability of users to replenish and correct the content.

To eliminate the shortcomings of wiki systems associated with the com-plexity of data retrieval, a semantic wiki was created - a web application that uses machine-processed data with strictly defined semantics in order to expand the functionality of a wiki system.

To further expand the functionality of wiki systems, it is advisable to integrate them with artificial intelligence technologies. This will make it pos-sible not only to search for information in the existing database, but also to expand this database due to the semi-automatic generation of new objects required by the user. To solve this problem, Expertpedia was created using the technology of expert programming.

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ON THE ISSUE OF CREATING A DRIVING FORCE WITHOUT EJECTING REACTIVE MASS: THEORY AND PRELIMINARY RESULTS OF EXPERIMENTAL RESEARCH

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Abstract. The contradiction of the equations of momentum for absolutely inelastic impact of masses of gas and solids is noted. To solve the problem recognized in science, it is proposed to take the fundamental equation of energy, including efficiency. Then it is possible for a driving force (thrust) to arise due to different values of the efficiency of the processes of rejection and attachment of the same mass in a device with a rigid (elastic) asymmetry. At the same time, the ambiguous results of experiments can be explained by the proposal of the famous physicist V. Pauli to consider the possible emergence of an additional force from other reasons. As a hypothesis, the possible emergence of a driving force at the atomic level, when the nucleus vibrates in an asymmetric system, arising, for example, during acceleration, has been proposed.

Keywords: momentum equation, added mass, ballistic pendulum, inelastic impact.

In recent decades, numerous experimental studies have confirmed the possibility of creating thrust for propellers without ejecting mass, which is relevant, especially for space technology. The problem here, first of all, is the explanation of this phenomenon or effect without violating the conservation laws. Understanding the physics of the process of generating thrust without ejecting mass will qualitatively improve its efficiency. In general physics [1], the conservation equation for the momentum (the product of the velocity w and the mass m) for two interacting rigid bodies (we denote them by m_1 and m_2, we assume that the body m_2 is at rest before the impact, and after the impact, the bodies move together, and the body

m_2 becomes added mass) with an absolutely inelastic impact was initially taken as follows:

$$w_1 m_1 = w_2(m_1 + m_2) \text{ or } w_2(m_1 + m_2)/w_1 m_1 = 1 \quad (1) \qquad (1)$$

i.e. it does not reflect impact losses. In this case, the impact losses are reflected in the energy equation.

In applied gas dynamics [2], in particular for an ejector thrust amplifier (ETA), the momentum equation has an efficiency η, that takes into account the impact losses. Here, to increase the thrust, the principle of mass addition is implemented [3].

In confirmation of equation (1), an experiment is given [1] with a bullet hitting a box of sand suspended like a pendulum, the mass of which is 1000 times the mass of the bullet. It was found that the efficiency of the process is 0.001. The question arises how correct this is: the experiment is the only one, and the obtained efficiency is only a thousandth of the maximum value and what would happen to the results if the box was filled with material with a different resistance to bullet penetration or if its mass was increased. Probably, there were other experiments, but their results are not shown. Theoretically, all mechanical energy can be converted into heat and that then the momentum will also be conserved? Impulse is the presence of speed, speed is mechanical energy. I.e. no speed - no momentum.

Let's make an assumption: we derive equation (1), as in the ETA theory [2], from the energy equation

$$w_2^2(m_1 + m_2)/w_1^2 m_1 = \eta . \qquad (2)$$

Let us transform this ratio for energies into a ratio for the number of movements, as it was done [2]

$$\frac{w_2}{w_1} \frac{(m_1 + m_2)}{m_1} = \sqrt{\frac{m_1 + m_2}{m_1}} \eta \qquad (3)$$

which in the general case is not equal to 1, which contradicts equation (1). This ratio is determined by the ratio of mass and efficiency, corresponds to the equation of momentum for ETA, which is obtained in the same way. Three parameters m_1, m_2, η can be changed, set independently of each other, and therefore 1 can be obtained only by a special selection of these parameters. I.e. as a special case (identity), for certain values of m_1, m_2 and η it can be equal to 1 and correspond to equation (1). Here m_2 is the added mass [4].

A retrospective analysis of the relationship between the momentum mw and the kinetic energy $mw^2/2$, was carried out, which showed that

even from the time of Newton and until the middle of the twentieth century, there was no unambiguous attitude to this. It is advisable to bring here the attitude of well-known scientists to the problem and quotations from works [5, 6]:

- Newton – "the idea of maintaining movement was alien to him; in support of his view, the great scientist cited the impact of inelastic bodies, believing that in this case the destruction of motion takes place";

- Leibniz – "believed that the true measure of motion is the product of mass by the square of the speed of the body, and when inelastic bodies collide, the amount of motion always decreases";

- Pauli – in the first half of the twentieth century, he argued that "one should also expect a certain connection between the laws of conservation of energy and momentum and the properties of space and time..." [6].

As it was shown above, Abramovich G.N., the author of work [2], obtained the equation of momentum from the equation of energy. Thus, the position of these scientists suggests the relationship of the equation of momentum and the equation of energy.

Numerous experiments are known with devices that create thrust without ejection of the jet mass. Some of the devices are called inercoids. Their design usually has a fluctuating mass. Here it is possible to create an impulse when an unbalanced force appears due to different values of the efficiency of the processes of rejection and attachment of the same mass. I.e. in the device created in accordance with equation (3) there must be a stiff (elastic) asymmetry [4, 7].

To confirm the obtained theoretical positions, it is possible to create an installation of the "inercoid" type, in which, according to equation (1), it would be possible to change at least the mass of one body (m_1 or m_2) and the efficiency η of the mass interaction process. Here, as in ETA, the well-known principle of mass addition works, which makes it possible to increase the momentum under certain conditions [3].

Such an experimental setup will require special design, research, and will be quite complex. Therefore, in the first approximation, a simplified installation (from improvised means) was implemented, in which initially only the efficiency of the process of interaction of masses η was changed due to the setting of replaceable inelastic spacers between the interacting masses. The purpose of the experiment is to show, as noted above (within the framework of classical mechanics), the possibility of creating a driving force without ejection of reactive mass and to draw attention to studies on the implementation of the effect in technology and its possible manifestation in nature [4]. The diagram and photo of the setup are shown in fig. 1,

2. The installation consists of a trolley 1, on which stops 2, 6 are fixed, a solenoid 5 with an anchor rod 4. On the stop 2 there is a replaceable in-elastic spacer 3 (for example, made of plasticine). For long-term operation, instead of laying, it is necessary to create a special device for dissipating energy [2], which would also complicate the installation. On the stop 6, a return spring 7 is fixed, with the other end connected to the anchor rod. The solenoid is supplied with short pulses of 300 volts. Taking into account some energy dissipation for friction in the solenoid, the spring, it was de-cided to carry out comparative tests with gaskets of different elasticity, as well as without them (elastic impact of the armature rod against stop 2).
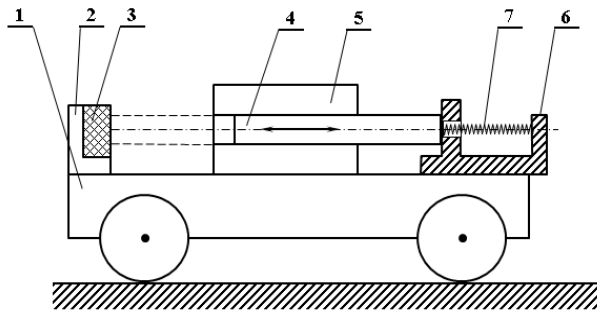

Figure 1. Experimental setup: 1 – cart; 2 – stop with spacer; 3 – inelastic spacer; 4 – rod - anchor; 5 – solenoid; 6 – emphasis; 7 – return spring.
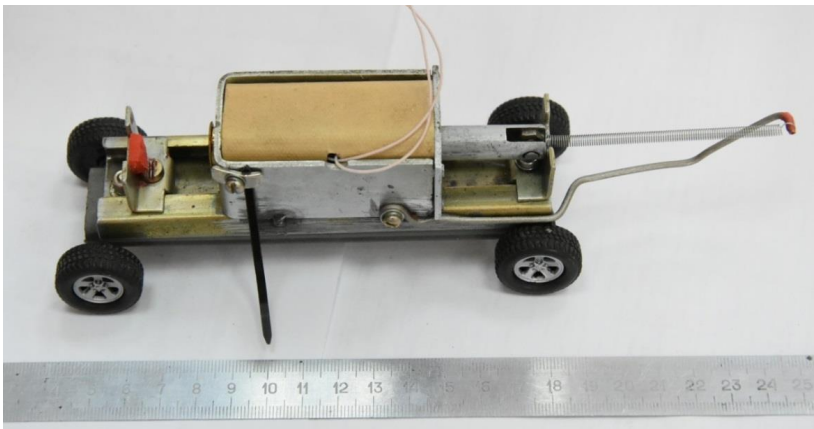
Figure 2. Photo of the experimental setup

The installation works as follows. When a voltage pulse is applied to the solenoid, the armature rod 4 hits the spacer 3, which deforms and dissipates some of the energy. After the termination of the pulse, under the action of the return spring, the core hits the stop 6 and takes the position shown in fig. 1 and 2 (photo).

During the tests, the movement of the cart was observed, i.e. an unbalanced driving force was created, similar experiments reported on the Internet were confirmed. However, the results were not consistent, and not only when replacing the gaskets. Any regularities in the course of the experiment were not established, it was not possible to systematize the result. In part, this can be explained by design flaws, not ensuring the purity of the experiment. However, there may be other negative factors due to which a sustained critical attitude towards these devices has been formed. To identify possible factors influencing the experiment, it was decided to simplify it to the level of interaction of a bullet from a pneumatic pistol with the mass of a ballistic pendulum, as in [1].

The estimation of the process parameters of a single impulse was carried out in the same way as in [1]. Initial conditions:
- bullet (m_1) weighing 0.2g;
- bullet speed is taken as an average of 150 m/s;
- pendulum length 0.5 m;
- the maximum lifting height h of the mass m_2 was measured.

In the place of interaction of the masses, gaskets of different elasticity were installed: "soft" and "hard". The experimental setup is shown in fig. 3, and the experimental data are in the table.

Figure 3. Diagram of an experimental setup based on a ballistic pendulum

Table.

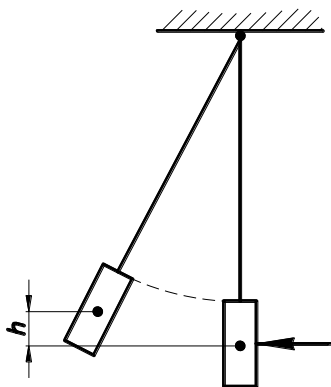| №	m_2, kg	m_1, kg	h, cm	η	Terms of interaction	$\sqrt{\dfrac{m_1 + m_2}{m_1}}h$
1 [1]	10	0, 01	4	0, 001	Sand box	1
2	0.058	0.0002	3.9	0. 01	Hard	1.7
3	0.058	0.0002	2.5	0. 006	Soft	1.32
4	0.025	0.0002	9.5	0. 01	Soft	1.12
5	0.025	0.0002	10	0. 011	Hard	1.17

The results obtained for a single pulse, presented in the table, are of a qualitative nature and allow us to draw the following conclusions:

- the experiment given in [1] (first line from the top) should be considered only as a special case that does not contradict the obtained relation (3), it is of practical importance for assessing the speed of bullets;

- expression $\sqrt{\dfrac{m_1 + m_2}{m_1}}h$ in the performed experiments it is not equal to 1 and depends on m_1 or m_2 and the efficiency η of the process of interaction (attachment) of masses, i.e. the connection between the equations of momentum and energy is confirmed. As with ETA, an increase in added mass and efficiency leads to an increase in momentum.

Considering also the ambiguous results of experiments with an inertsoid under the action of multiple impulses, we should recognize Pauli's statement about "...a certain connection between the laws of conservation of energy and momentum..."(let's call it "Pauli's second principle") and try to more fully define this connection. At the same time, taking into account the positive experience of the studies carried out by other authors, it is necessary, first of all, to learn how to tune out the harmful influence of this connection, for example, to go to lower operating frequencies of the device [7].

It is proposed to consider, as a hypothesis, the possibility of applying the principle of the inercoid mechanism to create a driving force at the atomic level. It is known that all atoms of a solid undergo thermal vibrations. There are strong interactions between the atoms of a solid. The nucleus, in which the mass of the atom is concentrated, vibrates in the system: "nucleus - electron shell". The rigid asymmetry of this system can be created due to the deformation of the electron shell by a magnetic field or displacement of the nucleus under the action of acceleration. The

influence of centrifugal acceleration on weight is confirmed by experiments with gyroscopic devices. Thus, the effect of the effect at the atomic level on the results of the entire experiment with the device is possible. This can be a manifestation of the above, "Pauli's second principle". It can be assumed that in the experiment with a bullet [1] other versions of its execution were also realized, but they did not give unambiguous results, did not receive an explanation, and therefore are not presented in [1]. Perhaps this is also the reason for the well-known problem - the existing discrepancy between the experimental and calculated results (obtained using modern numerical methods) of studies of highly non-stationary gas-dynamic processes. To solve the problem, it is advisable to study the theory of high-speed impact and cumulative jet, where phenomena at the molecular level are considered.

Conclusion

The lack of clear definition in the theoretical positions and in the results of experiments on the absolutely inelastic interaction of masses of gas and solids requires fundamental research, taking into account the possibility of additional driving forces arising, for example, at the atomic level. The creation of an experimental setup should provide for a fairly wide range of changes in its parameters. Without a solution to the problem, the development of some types of propulsion systems, mainly with a pulsating working process, can be inhibited.

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DECREASING COMBUSTIBILITY OF SYNTHETIC MATERIALS

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Abstract. The conducted studies have proven more effectiveness in using Florimp and Foginol to decrease the combustibility of the polyester fibers, polycaproamide fibers and polyacrylonitrile fibers and textile materials based on them.

Keywords: synthetic fiber, modification, fire hazard, fire retardants, combustibility parameters, physical and mechanical properties, pyrolysis and combustion.

The presence of functional groups makes synthetic fiber modification possible; it intensifies the process of structuring during pyrolysis that leads to the increase in coke output as well as combustion elimination. However, there aren't enough effective fire retardants for this purpose. That's why studies of pyrolysis peculiarities for the phosphorus containing fire retardants having different compositions and, also, thermal-oxidative degradation regularities for the modified polymers are of current importance. Finding a solution allows to regulate the pyrolysis and the combustion pro-

cesses and, also, to lower the fire risk. Industry produces small and medium tonnage outputs of thermostable and inflammable aromatic fibers and special-purpose threads. They are togylene, tverlane, arselone, arymide and others, which are rather expensive [1-3].

Large tonnage textile materials based on the thermoplastic fiber-forming polymers of polyethyleneterephthalate (PETPH), polyacrylonitrile (PAN), and polycaproamide (PCA) are comparatively cheap and widely used. But they are from the category of highly inflammable polymers, which are characterized by the high speed of combustion and toxicity of pyrolysis products. These factors put limit on their use in the number of industries. The presence of functional groups makes their modification possible; it intensifies the process of structuring during pyrolysis that leads to the increase in coke output as well as combustion elimination. However, there aren't enough effective fire retardants (FR) for this purpose. That's why studies of pyrolysis peculiarities for the FR having different compositions and, also, thermal-oxidative degradation regularities for the modified polymers are of current importance. Finding a solution allows to regulate the pyrolysis and the combustion processes and, also, to lower the fire risk.

In this connection, to evaluate a possible use of a certain chemical nature FR for different synthetic fibers, this research has been done to determine the influence of phosphorus containing FR of Florimp and Foginol on the pyrolysis procedure, combustion characteristics and physical and mechanical properties of polycaproamide (PA), polyester (PE) and polyacrylonitrile (PAN) fibers and textile materials based on them.

In our previous research [4-6] aimed to determine the modification parameters we studied cybernetics of FR sorption by fibers under different conditions. The modification was made by Florimp and Foginol water solutions, at temperatures of 20 and 85°C, with bath module of 10 and FR content from 10 to 50 % mass. The modification of the PA and PE fibers by 10-50 % solution of the Florimp and Foginol fire-retardant additives at the temperature of the modifying solution of 20°C was found to be made for 120 sec for PE fibers and for 180 sec for PA fibers at Florimp modification, and for 120 sec for both at Foginol modification. It is more effective to modify a newly formed, the so-called "gel", rather than a finished PAN fiber. It allows to include the modification into the technological process. The structure of the gel fiber is not completely formed; it has high porosity and sorptive power. The most effective temperature for the PAN gel fiber modification is 20°C for 120 sec with Florimp and for 180 sec with Foginol.

With all this going on, the modification results in maximum FR weight increment, % of 17-20 % mass for PAN, 19-22 % mass for PA and 23-23,5

% mass for PE (Fig. 1).
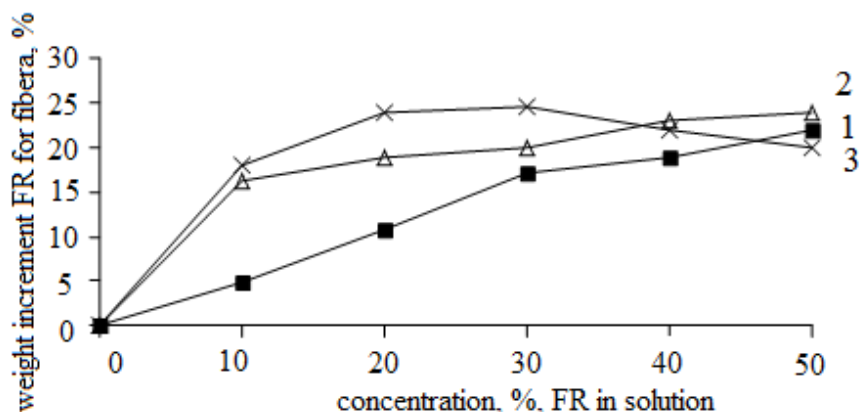
Figure 1. FR content in Florimp modified fibers: 1 – PAN gel fiber; 2 – PA fiber; 3 – PE fiber.

Studies of the FR influence on the modified fiber pyrolysis reveal coincidence of the degradation initial temperatures (260°C) for both, Florimp and PAN fibers (Table 1).

Table 1.
TGA data for modified fibers

№	Sample composition, % mass	Degradation temperature, °	Mass loss, %, at Tf	Mass loss, %, at temperature, °				
				300	400	500	600	700
1.	100 Florimp	$\frac{260 - 350}{326}$	74	34	78	84	87	87
2.	100 PAN	$\frac{260 - 290}{270}$	15,5	16	22	32	41	62
3.	80 PAN + 20 Florimp	$\frac{250 - 280}{260}$	14	18	25	35	49	65
4.	100 PE	$\frac{360 - 455}{410}$	32	0	10	83	95	100
5.	77 PE + 23 Florimp	$\frac{360 - 460}{420}$	44	4,5	14	82	84	85

6.	100 PA	$\dfrac{345-480}{420}$	95	5	36	98	100	100
7.	79 PA + 21 Florimp	$\dfrac{315-380}{360}$	69	4,8	70	82	89	94

* Ti – initial temperature; Tf – final temperature.

These studies were conducted by thermogravimetric analysis (TGA) technique. In the temperature range of 260-350°C the PAN fibers enter the stage of cyclization. The Florimp additive initiates the PAN fiber cyclization that is proved by the initial temperature drop of 10-15° and by the presence of exothermal peaks on the TGA curves of the cyclization.

The Florimp additive influences the PA and PE fiber pyrolysis too, and it increases the coke output (Table 1). Changes taking place during polymer pyrolysis should influence the fiber combustibility.

The combustibility was estimated by oxygen index (OI) (GOST 12.1.044-89). With modification of Florimp fibers the OI for PE increases up to 30,5-31 % vol., for PA up to 27,5-28,7 % vol. and for PAN – up to 28,5-29 % vol. (Fig. 2).
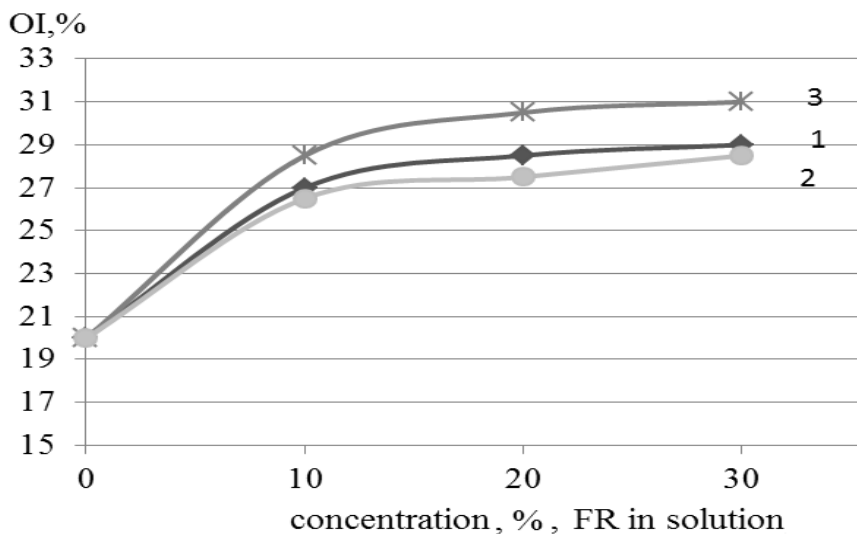
Figure 2. Influence of Florimp solution concentration on OI:
1 – PAN gel fiber; 2 – PA fiber; 3 – PE fiber

Fibers modified by Foginol additive have lower OI values; they are 28,5 % vol. for PE, and 27,5 % vol. for PA and PAN.

It was found that the PE fiber could be modified more effectively from the solution containing 20 % mass FR. Further increase of the FR concentration results in OI increases by 1-1.5%. It is most likely caused by the FR molecule aggregation in the solution, where the increase of the FR concentration gives the decrease of the FR weight increment per a fiber. Additional thermal treatment does not considerably affect the value of fiber combustibility.

Modification, as a rule, results in structural fiber changes, and it affects the physical and mechanical properties. That's why the influence of Florimp and Foginol modification on deformation and strength behavior has been studied. Figure 3 shows that strength of the modified PAN gel fibers with a titer of 0,27 tex increases by 8-10 % (Fig. 3), and elongation decreases by 12-18 %.
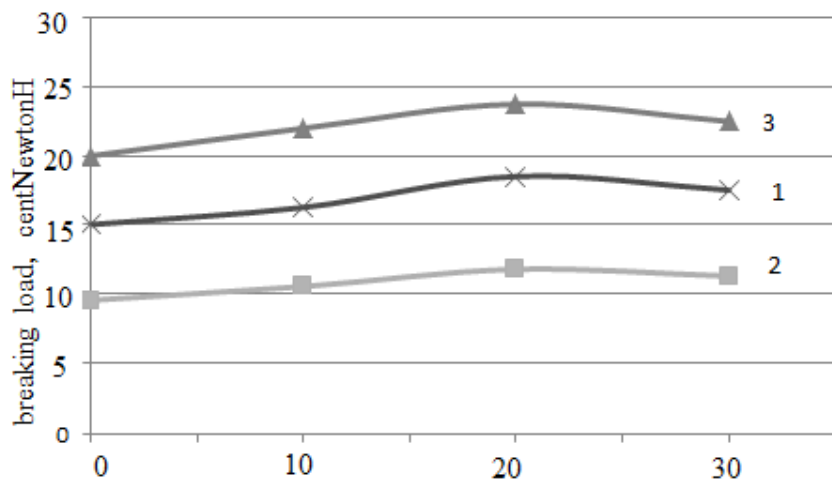
Figure 3. Strength of Florimp modified fibers: 1 – PE fiber; 2 – PA fiber; 3 – PAN fiber

Florimp and Foginol modified PA fibers with a titer of 0,29 tex have the strength value that is comparable with the value of the starting fiber (increases by 1-3,5 %) (Fig. 3).

The strength of the PE fiber with a titer of 0,33 tex increases by 12-16 % (Fig. 3). The elongation of the modified fibers does not reveal any con-

siderable changes.

Thus, the conducted studies have proven more effectiveness in using Florimp and Foginol to decrease the combustibility of the polyester fibers, polycaproamide fibers and polyacrylonitrile fibers and textile materials based on them.

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REGULARITIES OF CORROSION AND CORROSION-MECHANICAL WEAR OF DIFFUSION BORED LAYERS

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Abstract. A qualitative analysis of the corrosion and corrosion-mechanical destruction of borated diffusion layers was carried out, and tests were carried out in a 10% aqueous solution of H_2SO_4. The measured values of the stationary electrode potentials of the doped boronized layers are presented. The subsurface nature of the destruction of the boronized layers under the given conditions is shown. The time of effective corrosion protection has been determined.

Keywords: electrochemical corrosion, boronized layers, electrode potential, anodic and cathodic processes, subsurface corrosion, effective protection time.

The high corrosion resistance of boronized layers was noted in a number of works [1-3]. The multiple effects of increasing the corrosion resistance obtained in these works are explained by the short duration of the tests and the choice of convenient comparison objects, which are practically not used as corrosion-resistant materials. At the same time, individual parts made of low-alloy steels with boride layers can be used for short-term corrosion protection as substitutes for high-alloy corrosion-resistant steels. In some cases, such use can be justified from an economic point of view, but in any case, the limited time for effective protection should be taken into account. After this time, the parts must be replaced or secondary boronization [4].

Homogeneous, defect-free protective coatings provide maximum corrosion resistance. The choice of a protective coating, especially a heterogeneous one, is dictated not only by its corrosion resistance (electrochemical heterogeneity), but also by its electronegativity with respect to the substrate material and associated parts, density, the level of stress state and the nature of destruction, which in many cases turns out to be decisive. In

particular, in the case of corrosive layer-by-layer destruction, peeling of the sections of the FeB phase of the boride layer is possible as a result of the effect of residual stresses [5].

Electrochemically inhomogeneous heterogeneous boronized layers with a eutectic, pseudo-eutectic structure, separate inclusions of borides in α-solid solution after combined or electron-beam boriding do not have sufficient corrosion resistance. For a more reasonable choice of a protective corrosion-resistant coating, a comprehensive analysis of the corrosion and corrosion-mechanical destruction of borated layers is required.

The intensity of corrosion and corrosion-mechanical destruction is determined by the electrochemical heterogeneity of the system. It occurs when diffusion multiphase coatings are applied on the surface of parts and when they work in conjunction with dissimilar materials in the presence of liquid or solid electrolytes (media with ionic conduction). Such a system causes the spontaneous functioning of galvanic and microgalvanic cells after assembly. The intensity of the work of galvanic pairs is determined by the difference between the electrode potentials of the components and their mutual placement in the series of voltages built for the electrolyte of the environment. It sets the rate of the redox process, the kinetics of which is characterized by polarization diagrams, taking into account the ratio of the reaction surfaces [6 - 8]. The greater this difference, the greater the likelihood of the corrosion process occurring at a high rate.

With a corrosive form of destruction and anodic coating, an anodic dissolution process occurs on it, and the base metal is completely protected, regardless of the defectiveness of the diffusion layer. The minimum rate of corrosion destruction uniform over the surface is observed with a continuous homogeneous defect-free layer, and when the sections of the second phase of the layer or sublayer open or in the presence of defects such as through pores, the corrosion rate increases sharply. The further rate of dissolution of the layer is determined by the ratio of the phase surfaces; however, the base metal still remains under cathodic protection.

With a cathode coating and a defect-free layer, the minimum corrosion rate is established only in the first period of time, i.e. until the sections of the second phase or metal base are exposed. When sections of the second phase or base metal open on the surface, intensive dissolution of the second phase or sublayer begins. That is, subsurface corrosion develops, accompanied by the formation of deep caverns. The rate of subsurface destruction will be determined mainly by the rate of removal of reaction products from the interaction zone.

An illustration of the regularities of corrosion destruction of borated lay-

ers on steels was carried out in a 10% aqueous solution of H_2SO_4, and corrosion-mechanical destruction - in the same solution with the addition of an abrasive powder (SiC).

The plotted series of voltages of stationary electrode potentials for the selected solution (Fig. 1) showed that boride layers are cathodic coatings for iron.

Stationary electrode potentials were determined by the express method using a carbon-oxygen reference electrode [9-11].

Different values of stationary electrode potentials of boride layers are determined by the phase composition, the phase ratio in the layer and the degree of their doping (Table 1).
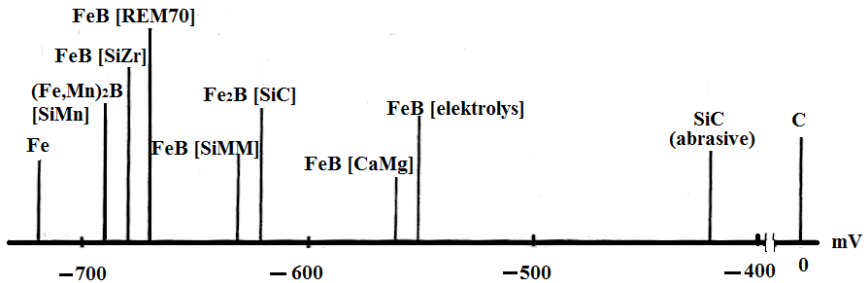
Figure 1. Electrochemical series of voltages of doped borated layers obtained in molten salts with different powder additives (in square brackets) in a 10% aqueous solution of H_2SO_4

In accordance with the location of the layers in the electrochemical series of voltages, the minimum corrosion rate with a continuous defect-free layer (before the opening of the second phase sections) should be expected from non-alloyed two-phase layers obtained by electrolysis saturation, or silicon-doped two-phase layers obtained in baths in which, as an electrochemical reducing agent used calcium-magnesium ligature. These layers have the lowest electronegativity in the considered electrolyte as compared to other borated layers. When the continuity of the layer is disrupted, intensive corrosion destruction of the sublayer begins as a result of a large difference in the values of stationary electrode potentials with iron, i.e. subsurface corrosion develops.

Table 1.
Legend and phase composition of the studied borated layers

№№	Designation of a layer in a series of voltages	The composition of the saturating medium	Phase composition of the layer	Alloying elements
1	$(Fe,Mn)_2B$ [SiMn]	60% $Na_2B_4O_7$, 10% NaCl, 30% SiMn (силикомарганца)	$(Fe, Mn)_2B$	Mn, Si
2	FeB [REM70]	60% $Na_2B_4O_7$, 10% NaCl, 30% REM70 (ligature containing 70% REM)	FeB+ Fe_2B	Si, REM
3	FeB [SiZr]	65% $Na_2B_4O_7$, 10% NaCl, 25% SiZr (silico-zirconium)	FeB+ Fe_2B	Si, Zr
4	FeB [SiMM]	70% $Na_2B_4O_7$ и 30% SiMM (silicomishmetal)	FeB+ Fe_2B	Si, REM
5	Fe_2B [SiC]	70% $Na_2B_4O_7$ и 30% SiC	Fe_2B	Si
6	FeB [CaMg]	60% $Na_2B_4O_7$, 10% B_2O_3, 30% CaMg (calcium magnesium ligature)	FeB+ Fe_2B	Si
7	FeB	100% $Na_2B_4O_7$ (electrolysis)	FeB+ Fe_2B	-

The minimum rate of subsurface corrosion in destruction of the continuity of the borated layer should be ensured by layers that have a minimum difference between stationary electrode potentials with iron. According to a number of voltages, such layers include single-phase borated layers based on $(Fe, Mn)_2B$ obtained in an electrolysis-free saturation bath with silicomanganese.

The tests carried out have fully confirmed these provisions (Fig. 2). The sharp increase in weight loss is due to the opening of the metal sections of the sublayer.

It should be noted that borated layers obtained at a lower temperature, in all cases, have advantages in corrosion resistance in the studied area

due to their higher density and defect-freeness. The microstructure of the surface layer after corrosion destruction clearly indicates its subsurface nature (Fig. 3). Such a nature of destruction cannot be taken into account when predicting the durability of a part, but it is it that is very dangerous for critical parts and assemblies.

To obtain comparable results, the same thickness of the borated layer, equal to 100 microns, was ensured by varying the duration of treatment, since the saturating capacity of the baths is different.
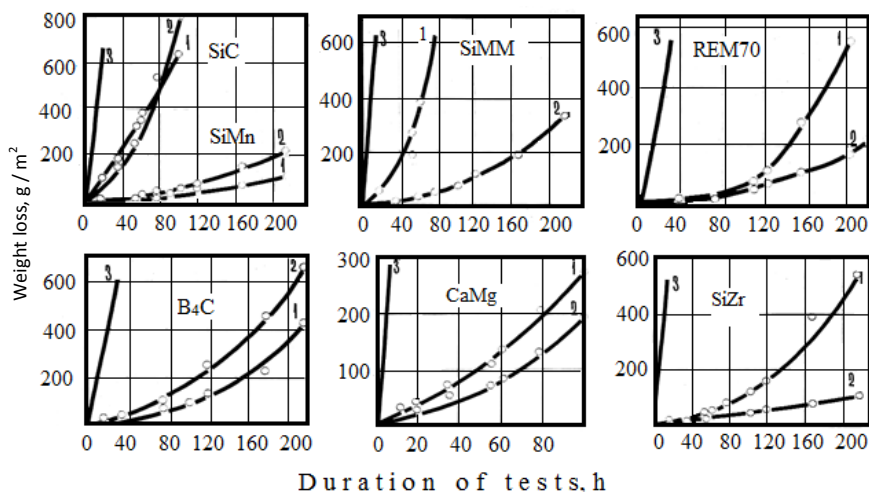
Figure 2. Kinetics of corrosive destruction of borated layers obtained in borax melts with the addition of powders of electrochemical reducing agents (indicated in the graphs):
1 - Saturation temperature 950⁰C; 2 - Saturation temperature 800⁰C;
3 - Unborated steel C 1034.

The structure of the sublayer also influences the development of corrosion damage. In particular, an increase in the carbon content in the sublayer of steel C 1034 in the process of boriding and the formation of inclusions of carboborides [$Fe_3(C, B)$] in this zone shifts the stationary electrode potential of the sublayer in the series of voltages to the right. Depending on the amount of carbon and carboborides in the sublayer, its stationary electrode potential may turn out to be equal or even less electronegative than the stationary potential of a single-phase boride layer. This leads either to a decrease in the rate of subsurface corrosion destruction of the sublayer,

or to the occurrence of anodic dissolution of the boride layer itself. In the example under consideration, the discontinuity of the single-phase boride layer led to anodic dissolution of borides at the boride-sublayer interface, as evidenced by internal ulcers in the boride layer (Fig. 3, a).

With the corrosive destruction of two-phase boride layers after the discontinuity of the outer FeB phase, anodic subsurface dissolution of the Fe_2B phase began, and with the subsequent disruption of the continuity of this phase, anodic subsurface dissolution of the base metal occurred (Fig. 3, b). In this case, the structure of the sublayer has practically no effect on the process of corrosion destruction.

In the case of mechanical corrosion wear, different variants of the location in the series of stresses of the interacting materials should be considered, i.e. the values of stationary electrode potentials of the base metal (φ_{Me}), boronized layer (φ_L), and abrasive (φ_a). Anodic dissolution of the borated layer occurs upon interaction with the abrasive, and the cathodic process in the layer occurs upon interaction with the base metal. This type of interaction is observed in the analyzed case with subsurface corrosion of borated layers in the selected electrolyte (Fig. 3, c, d).
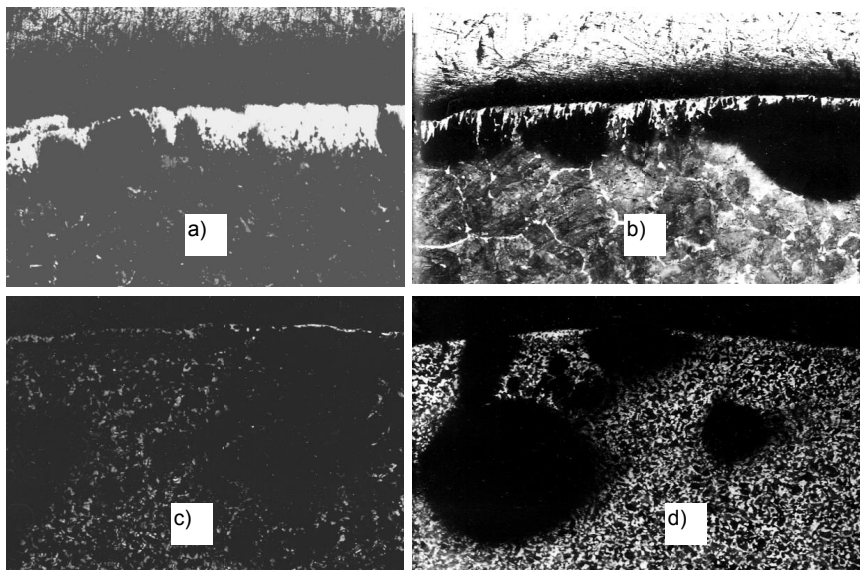

Figure 3. Microstructures of borated layers on steel C 1034 after corrosion (a, b, × 200) and corrosion-mechanical (c, d, × 50) wear: a, c - single-phase layers; b, d - two-phase layers

With the established procedure for placing the stationary electrode potentials of interacting materials by electronegativity ($\varphi Fe < \varphi Fe_2B < \varphi FeB < \varphi SiC$) in the selected electrolyte, the corrosion-mechanical wear of two-phase and single-phase borated layers is as follows. It begins with the anodic dissolution of a continuous layer at a higher rate than during corrosion interaction, due to the work of microgalvanic elements, the layer is an abrasive and due to mechanical action on the surface of the abrasive particles. The abrasive in this case cuts off the protrusions of the boron surface at the point of contact. When the sections of the second phase open with a two-phase borated layer or base metal with a single-phase borated layer, the subsurface corrosion rate increases sharply. This process is aggravated by the destruction of the remaining bridges of the boronized layer by abrasive particles and the complete opening of subsurface cavities.

It should be expected that, in accordance with the location of the interacting materials in the series of voltage, the rate of corrosion-mechanical destruction of two-phase layers will be lower than the rate of destruction of single-phase layers due to the smaller difference between the stationary electrode potentials of the layer and the abrasive. Considering that the hardness of single-phase layers is lower than that of two-phase layers, the rate of corrosion-mechanical destruction of single-phase layers increases even more depending on external conditions (the hardness of the abrasive, its content in an aggressive medium, the circulation rate of this medium).

Investigations of corrosion-mechanical destruction were carried out on an installation that provided free movement of abrasive, aggressive medium and test samples in a closed retort when it rotated according to the principle of a "drunken barrel". The rotation speed was 480 rpm. The volume of the retort was filled in half with a mixture of abrasive and electrolyte, taken in a weight ratio of 3: 2.

The results obtained from tests of two-phase and single-phase borated layers formed on steel C 1034 upon saturation from molten salts using various electrochemical reducing agents showed that layers doped with rare-earth metals and zirconium have the greatest resistance under these test conditions from two-phase layers. Among single-phase layers, boride layers doped with manganese have the highest resistance (Fig. 4).

The practical significance of the results obtained is to determine the effective protection time of the steel substrate with various borated layers in a 10% aqueous solution of H_2SO_4 (Table 2), which for corrosion destruction is 60-225 hours, and for corrosion-mechanical destruction - 35-100 hours. When this time is exceeded, the processes of subsurface destruction begin to actively develop.
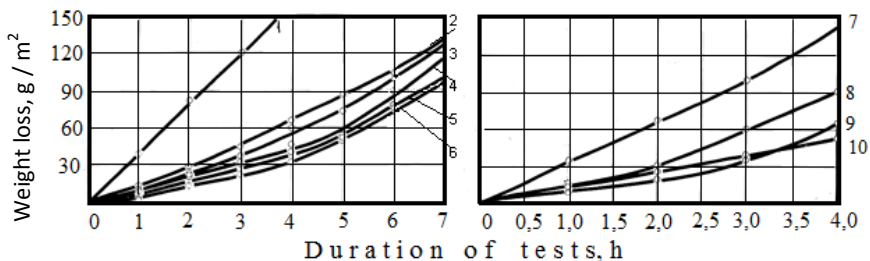
Figure 4. Influence of test duration on weight loss of boride layers obtained in baths with various electrochemical reducing agents on steel C 1034:

1- steel C 1034 (unborated); 2 - REM70; 3 - CaMg; 4 - B_4C;

5 - SiMM; 6 - SiZr; 7 - SiC (950°C); 8 - SiC (800°C); 9 - SiMn (800°C); 10 - SiMn (950°C).

Table 2.

Influence of alloying on the time of effective protection of steel C 1034 during corrosion and corrosion-mechanical wear

Wear type	Time of effective protection (h) when doping borides with various elements				
	Two-phase layers (FeB + Fe_2B)			Single-phase layers (Fe_2B)	
	-	REM	Zr	Mn	Si
Corrosive	80/80	60/60	225/120	225/225	150/160
Corrosion-mechanical	40/35	35/40	100/60	30/40	15/30

Note: In the numerator, the effective protection time of the layers obtained at 800°C, in the denominator - at 950°C.

Conclusion

The conducted research has shown the existence of different types of corrosion and corrosion-mechanical destruction of boronized layers. An indicator of the nature of destruction is the values of stationary electrode potentials measured in an aggressive working environment and, for clarity, presented in the form of electrochemical series of voltages. The paper defines the conditions for the occurrence of anodic and cathodic processes on the surfaces of borated parts and in the sublayer, as well as the development of subsurface corrosion. The best protection indicators are possessed by single-phase (Fe_2B), alloyed with manganese, borated layers

and two-phase (Fe$_2$B + FeB) - alloyed with zirconium with the maximum time of effective protection.

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EXPERIMENTAL STUDY OF NATURAL VIBRATION FREQUENCIES OF CURVED PIPES OF NON-CIRCULAR CROSS-SECTION[1]

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Abstract. Curved tubes of non-circular cross-section are widely used in various fields of technology. An increase in the intensity and frequency of vibrations of units, installations lead to increased wear of mechanisms and, as a result, can lead to a disruption of the technological process. So the question of determining the parameters of the vibrations of these elements, in particular, manometric tubular springs, becomes more significant. The technique and test results of natural vibration frequencies and damping coefficients of tubes in various damping media - air, water and glycerin are presented. AU014 vibration analyzer and SV-10 vibration viscometer were used for research. The experimental results were compared with the calculated values.

Keywords: pipes of non-circular cross-section, vibrations, natural vibration frequencies, damping coefficient

Introduction

Curved pipes of non-circular cross-section were originally used as elastic sensing elements in pressure and temperature measurements [1] called Bourdon tubes or gauge tube springs (GTS). To increase resistance to loads in vibration-resistant pressure gauges, they were placed in a viscous liquid.

Later they began to be used in robot drives [2], as power elements of

brakes [3], agricultural machines [4].

The growing intensity and frequency of vibrations of technological process units negatively affect the operation of these devices.

The works [5-10] are devoted to the estimation of the frequency characteristics of tube vibrations. In this work, we present experimental studies of the natural vibration frequencies and damping parameters of tubes in a viscous liquid.

Methods

The purpose of the experiment is to determine the effect of the viscosity of the medium on the natural frequencies and damping parameters of oscillations and to compare the experimental and theoretical values to determine the acceptability of the created calculation methods.

During the experiment, the following tasks were solved:

1. Determination of natural frequencies of vibrations of tubes in a viscous medium.

2. Determination of damping parameters of oscillations with different properties of the damping fluid;

3. Comparison of calculated and experimental data

As prototypes, we used steel manometric springs of elliptical section, manufactured at the Tomsk manometric plant of JSC "Manotom" (fig. 1).

Air, distilled water, and glycerin were chosen as damping materials. The kinematic viscosity was determined according to GOST 33-66 using a VPZh-2 capillary viscometer.

To determine the parameters of vibration damping, two methods were used.

1. Using the vibration analyzer AU014.

2. With a vibrating viscometer SV-10.
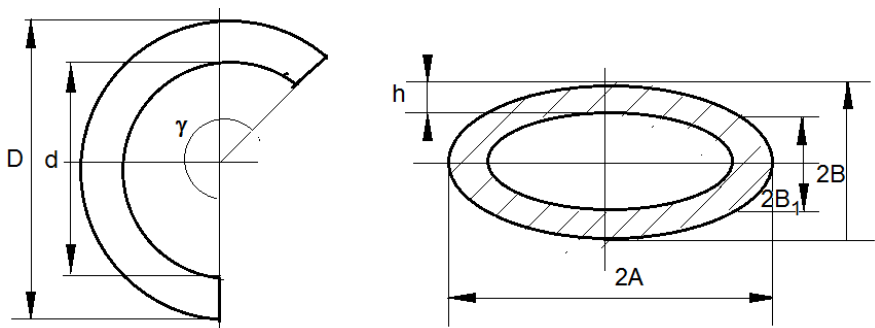
Figure 1. Gauge tubes

Table 1.

Geometrical parameters of tubes

Sample number	D, mm	d, mm	h, mm	γ, mm	A, mm	B, mm	B_1, mm
1	70.5	60.7	0.2	230	23.4	4.7	2.2
2	70.7	59	0.3	235	23	4.9	3.5
3	71.1	59	0.3	230	22.4	5.9	3.9
4	70.5	59.2	0.4	235	22.7	5.6	4.0
5	70.6	59.2	0.4	230	15.8	5.7	3.2
6	66.9	59.9	0.4	250	10.6	3.5	2.4
7	70.9	59.5	0.6	235	16	5.7	3.4
8	68.8	57.6	0.7	240	15.5	6.1	3.1
9	71.6	59.8	0.8	235	15.4	5.9	3.2
10	73	60.8	1.0	235	15.3	6.1	3.2

The work at the stand was carried out in the following order. The tube, placed in the container, is clamped in a vice. A vibration analyzer sensor is attached to the base of the tube. After setting it to standby mode, the test sample began to oscillate. The device receives signals from the sensor and after eight measurements gives the arithmetic mean value as a result.

When measuring with an SV-10 vibrating viscometer, the 014MT sensor was glued to the base of the spring with glue.

In the course of the experiments, the values of the frequency of damped oscillations and the damping coefficient - n - the values of the coefficient in the damping decrement formula, showing the ratio of the amplitudes of the subsequent and previous oscillations, were determined.

$$\eta = \frac{A_{i+1}}{A_i} = e^{-nT}$$

where A – amplitudes of oscillations, T – period of damped oscillations.

Results

The test results are presented in tab. 2-4

Table 2.
Damping parameters for air damping

Sample	1	2	3	4	5	6	7	8	9	10
Frequencies, Hz										
Estimate	89.3	139	160	175	198	180	235	274	275	301
Experiment (Au014)	83	126	146	165	182	171	223	256	257	279
Experiment (SV-10)	87	137	158	172	195	178	230	267	270	293
Attenuation coefficien, $\times 10^{-6}$ Hz										
Estimate	7.08	4.52	4.74	3.42	4.98	6.54	3.25	2.72	2.60	2.17
Experiment (Au014)	6.22	3.95	4.11	2.95	4.36	5.63	2.84	2.37	2.28	1.88
Experiment (SV-10)	6.53	4.28	4.41	3.19	4.59	6.16	3.03	2.56	2.41	2.03

Table 3.
The value of the attenuation parameters for damping with water

Sample	1	2	3	4	5	6	7	8	9	10
Frequencies, Hz										
Estimate	89.3	139	160	175	198	180	235	274	275	301
Experiment (Au014)	83	126	146	165	182	171	223	256	257	279
Experiment (SV-10)	87	137	158	172	195	178	230	267	270	293
Attenuation coefficien, $\times 10^{-3}$ Hz										
Estimate	0.35	0.22	0.23	0.17	0.25	0.33	0.16	0.13	0.13	0.11
Experiment (Au014)	0.30	0.19	0.20	0.15	0.22	0.29	0.14	0.11	0.12	0.10
Experiment (SV-10)	0.33	0.21	0.21	0.16	0.23	0.31	0.15	0.12	0.12	0.10

Table 4.

The value of the attenuation parameters for damping with glycerin

Sample	1	2	3	4	5	6	7	8	9	10
Frequencies, Hz										
Estimate	89.3	139	160	175	198	180	235	274	275	301
Experiment (Au014)	83	126	146	165	182	171	223	256	257	279
Deviation, %	7.2	9	8.8	5.7	8	4.9	5.3	6.7	6.4	7.2
Experiment (SV-10)	87	137	158	172	195	178	230	267	270	293
Deviation, %	2.2	1.4	1.4	1.6	1.6	1.3	2.3	2.6	1.8	2.8
Attenuation coefficien, Hz										
Estimate	0.53	0.34	0.35	0.26	0.37	0.49	0.24	0.21	0.19	0.16
Experiment (Au014)	0.46	0.30	0.30	0.23	0.32	0.43	0.21	0.18	0.16	0.14
Deviation, %	12.7	11.5	13.8	12.3	14.1	11.7	13.5	14.9	14.4	11.9
Experiment (SV-10)	0.49	0.32	0.34	0.24	0.35	0.46	0.23	0.20	0.18	0.15
Deviation, %	6.8	6.9	4.2	7.7	5.2	5.8	4.9	5.7	6.1	5.5

Discussion

A comparison of theoretical and experimental values showed that the frequency deviations did not exceed the instrument errors: 10% for the vibration analyzer Au014 and 3% for the SV-10 viscometer. The deviations of the values of the attenuation coefficient are slightly greater: for the vibration analyzer Au014 no more than 15% and for the SV-10 viscometer no more than 8%. This confirms the good accuracy of the methods given in [5-10] for various damping fluids.

Experiments have shown that the viscosity of a liquid has practically no effect on the natural vibration frequencies, and the attenuation coefficien sharply increases with an increase in viscosity.

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NUCLEAR MAGNETIC RESONANCE RELAXOMETRY METHOD FOR THE STUDY OF CRUDE OIL/WATER EMULSIONS AND DISPERSION OF WATER DROPLETS

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Annotation. Creation of the digital deposit with the control of oil-mining, preparation and transportation of crude oil by automated instrument-program complexes actual and expedient because it gives increase of oil extraction 10-25% and reduce energetic losses on 8% [1]. Express-control of the extracting crude oil for brigade account by GOST 8.615-2005 and to drive oil-well mining and preparing installations is actual. Was described the relaxometer of proton magnetic resonance (PMR), realizing the measurements of the PMR-relaxation parameters and calculating by the program written in notebook, characteristics of the oil-well liquid.

Keywords: express-control, oil-mining, relaxometer, proton, magnetic, resonance.

Creation of the digital deposit with the control of oil-mining, preparation and transportation of crude oil by automated instrument-program complexes actual and expedient because it gives increase of oil extraction 10-25% and reduce energetic losses on 8% [1].

The paper is devoted to nuclear magnetic resonance relaxometry (NMRR) method applications for the physical-chemical characteristics (PCC) study of crude oils, oil/water emulsions and dispersions by PMR-relaxometer. Method of pulse nuclear magnetic resonance relaxometry has great, yet not disclosed opportunities for the express analysis of fuels, oils and emulsions [2]. Structure-dynamical analysis by NMRR gives an opportunity to solve several problems of theory and practice.

Urgent requirement of oil-industry laboratories and oil preparation tech-

nology processes is the express-analysis of physical-chemical parameters of oil disperse systems, which are important for crude oils preparation: concentrations of water in crude oils and disperse distribution of water droplets in emulsions. During fifty years of its development pulse PMR-method proved its uniqueness as a powerful method equally suitable for refined scientific investigations and for routine analysis. It has the following advantages: simultaneous measurement of several oil characteristics; independence of the phase inversion in the oil/water emulsions; nondestructive and non contact control and automation, short measurement time.

PMRR-method gives information about relaxation parameters of the protons in i=3 phases: spin-lattice T_{1i} and spin-spin T_{2i} relaxation times, characterizing groups of protons with different molecular mobility; populations (or concentrations) of proton phases P_{1i} and P_{2i} (by our relaxometer we distinguish three phases); correlation times τ_{Ci} (times of the protons in definite molecular position); pre exponentials τ_{oi} (vibration periods of atoms); correlation times of atom exchanges τ_{Cei}; activation energies E_{Ai}; translation D_{tr} and rotation Drot diffusion coefficients; interproton distances R_{ij}; temperatures T_{Phi} of the phase transitions; degree of the protons phases ordering, derived from relaxation times ratio $S = T_{1i}/T_{2i}$ and others. This set of PMRR structure-dynamical parameters (SDP) combined with high resolution PMR-spectra with its lines positions and amplitudes, derived from free induction decay (FID) after 90°-pulse gives almost full picture about molecular dynamics of the studied oils.

Laboratory NMR-relaxometers, however cannot be used for the manual on-line control on technology process line, as well as for control of pollutions of soils and waters directly on nature and for protection of environment nature using methods of Carr-Purcell-Meiboom-Gill [3]. So we have designed new portable, easily transported relaxometers NMR NP-1 [4] and NMR NP-2 on programmable integrated base, with higher resonance frequency, weight less, then 12 kg, power supplied from accumulator 12 V or ≈ 220 V and connected with Notebook (fig.1).

Figure 1. Portable relaxometer NMR NP-2

It is used for express-analysis of PCP and has no prototypes. In Kazan, Perm, Ekaterinburg State Universities Relaxometers NMR NP are used for scientific researches and educational process. PMR-method almost need not sample preparation. Time of measurement is < 2 minutes.Sensibility is $K = v^2 D^3$ [MHz^{2}см^3] = 2700-4150 MHz^{2}см^3, which is near to "Minispec pc120" (Bruker,Germany). Magnetic system is built on rare earth elements alloys NdFeB. Probe coil heterogeneity of H_1 field is < 2% in the 75% of volume.

By the relaxometer were studied water-in-oil emulsions samples with 23.8 and 50.6 % w/w water content in oils of Romashkinskoye (Republic of Tatarstan) deposit. Oil №1 has the density ρ = 908 кg/m^3, viscosity η_{20} = 33.8 cP, concentrations of: asphaltenes (A) = 8.3 %w/w, resins (R) = 25.8 %w/w, sulfur (S) = 3.08 %w/w. Oil №2 has ρ = 987 кg/m^3.η_{20} = 39,5 cP, Asph = 10.3 %w/w, Res = 26.8 %w/w, S = 5.5 %w/w. Also oils with ρ= 873-879 kg/m^3 and concentration of salts C = 0.05M÷1M (2.6-53 g/l) were used. These oils and water concentrations were choosen because emulsions fromdense oils with high A and R, which are native surface ac-

tive substances, have the highest aggregative stability and are diffucult for separating. Emulsions were prepared on a propeller mixer with the rotation rate of 1500±500 rpm and time of mixing of 10±5 min. Stratum water used for samples had 3 g/l of salts (73 % of NaCl, 20 % of CaCl2, 7 % of $MgCl_2$).

For T_{1i} and P_{1i} determination spin-echo recovery pulse sequence 90-τ-$90°$-τ_0-$180°$ was used with the measurement parameters: delay time $T = 9$ sec, number of 180^0 pulses $N = 100$, step of sequence τ - 3 ms, number of accumulations $n = 3$. To determine T_{2i} and P_{2i}, pulse sequence of CPMG [4] was used with parameters: delay time $T = 9$ s, number of 180^0 pulses $N = 900$, interval between 180^0 pulses $\tau = 200$ μs, number of accumulations $n = 10$.

Water concentration determination by PMRR-method is realized by measurements of spin-spin relaxation times T_{2W} of pure water, T_{2O} of pure oil and T_{2m}^* of mixture using equation:

$$W = T_{2W} (T_{2m}^* - T_{2O})100\% / T_{2m}^* (T_{2W} - T_{2O}) \tag{1}$$

Number of $180°$-pulses N in is choosed from equation:

$$N = k3\rho_O - k4 \tag{2}$$

where ρ_O–density of oil in kg/m³, $k3 = 0{,}34$, $k4 = 284$. At low water concentrations W is determined using equation:

$$W = (T_{2W}T_{2O} - T_{2m}^*T_{2W} - W^*T_{2O}T_{2m}^*)/T_2^*(T_{2W} - T_{2O})100\%, \tag{3}$$

where W^* – part of water, added to the mixture.

Dependence of W_{NMR} from T_2^*(s) for oils of densities ρ = 865-908 кг/м³ and PDVSA (Venesuela) and Zuzeev (Romashkino deposite) with different number of CPMG $180°$ pulses in steady state presented at fig.2. For Zuzeev oil emulsions (Romashkino deposite, Republic of Tatarstan) dependence can be described by the linear equation:

$$W(\%) = 0.88 + 41.5T_2 \text{ (c)} \tag{4}$$
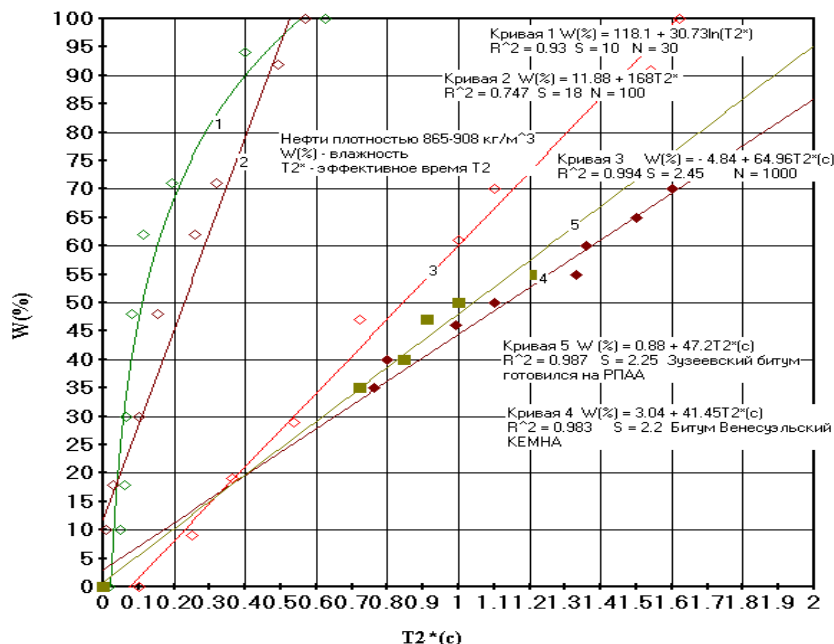
Figure 2. Dependence of W_{NMR} from T_2^*(s) Curves in oils: 1, 2, 3 – for N = 30, 100 and 1000; 4 – of PDVSA oil emulsions (Venesuela); 5 – of Zuzeev oil emulsions (Romashkino)

For droplets size distribution (*DSD*) determination exist the following methods: (*i*) microscopic analysis and (*ii*) hyper sound spectrometry, which need transparency or dilution. They are not express and cann't be used for on-line control. So PMRR is an alternative method of the *DSD* on-line determination, which can be used in nontransparent oil-water emulsions with inorganic impurities and gas bubbles. Measurements in relatively large samples masses ensure good representation. The limitation of the method is the effect of the self-diffusion coefficients D, which can be prevented by CPMG sequence [4].

DSD curves as the dependences of relative number of droplets with definite diameter $N_i/\Sigma N_i$ from droplets diameters D_i are presented at Fig.3 using microscopic data obtained by microscope MC-300 (Austria) with magnify 640x.
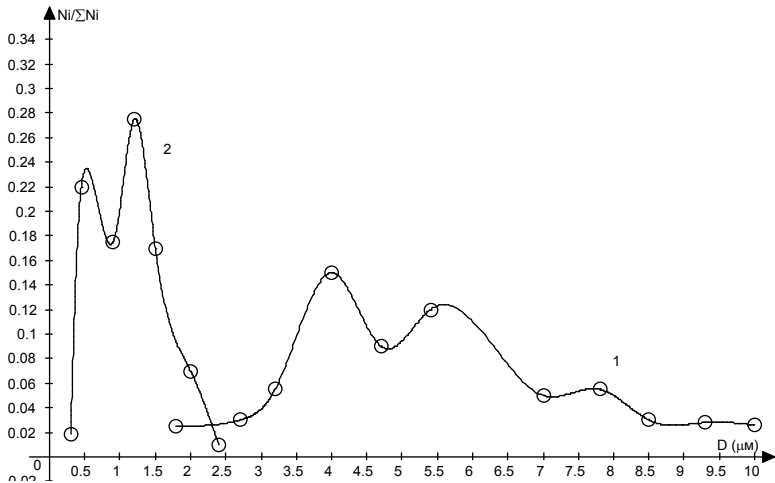
Figure 3. DSD for 28,3% emulsions, prepared at 1000 rpm (curve 1) and 1500 rpm (curve 2)

The integral *DSD* parameters: average diameters $D_{AV} = \Sigma N_i D_i / \Sigma N_i$ and Slauter (volume/square) diameters $D_{3/2} = \Sigma N_i D_i^3 / \Sigma N_i D_i^2$. were calculated and DmaxI and DmaxII diameters corresponding to the maximums of the *DSD* curves were calculated and determined from the curves. The data for small (SD) and large (LD) diameters are presented in Table.

Integral diameters and DSD-parameters determination errors for 28,3% emulsions, prepared at different mixer propeller rates

Table

28,3%emulsion, received at mixer rates:		Microscopic analysis				NMRR			
		D_{AV} µm	D_{MAX1} µm	D_{MAX2} µm	$D_{3/2}$ µm	D_{AV} µm	D_{MAX1} µm	D_{MAX2} µm	$D_{3/2}$ µm
SD-emulsion, 1500 rpm		1,9	0,6	1,3	5.2	1,6	0,9	2,3	3,8
LD-emulsion, 1000 rpm		6,2	3,9	5,5	14,0	6,7	1,9	3,5	14,6
Interme-thodic error $IMRE = D \cdot 100\% D_D$	SD-emulsion	1,0	1,0	1,0	4,6	-	-	-	-
	LD-emulsion	1,7	6,7	6,7	2,0	-	-	-	-

But microscopic method need several hours for DSD determination. That's why, we used PMRR –method for deriving of the correlations between D_{AV}, D_{MAX}, $D_{3/2}$ and relaxation times T_{1A} of water protons in droplets from data earlier obtained for samples of oils with intermediate density ρ = 870-910 kg/m³. The relation is described by the equation:

$$D_{AV}(\mu m) = 0.164 \exp(2.84 \cdot T_{1O} \text{ (sec)}) \tag{5}$$

It is in good agreement with the results of the work [5], authors of which found, that for water protons in the pores, relaxation rate $(T_{1,2})^{-1}$ is function of diameter

$$T_{1,2}^{-1} = T_{1,2B}^{-1} + [Dp/2\alpha \cdot \rho_{1,2} + D_p^2/4\beta D]^{-1} \tag{6}$$

where $T_{1,2B}^{-1}$ – relaxativity (relaxation rate) in bulk water, α - form factor, $\rho_{1,2}$ – rate of surface relaxation, β - include the shape factor and other parameters.

Other integral parameters of DSD: D_{max} and $r_{3/2} = D_{3/2}/2$ with correlation coefficients $R^2 = 0,95$ can be determined from equations:

$$D\text{maxl} = 0,32 \cdot \exp(1,37 \cdot T1O) \tag{7};$$
$$D_{3/2} = 4,80 \cdot (T_{1O})^{4,27} \tag{8}$$

Value of droplets diameters depend also from surface oil-water tension σ, and roughly (because they differ from oil deposit) from density ρ and water mineralization C_M by equations:

$$D_{AV}(\mu m) = 2.43 - 0.016\ \sigma^{20} \text{ (erg/см}^2) \tag{9}$$
$$D_{AV}(\mu m) = A + B \cdot \rho(kg/м^3) \tag{10}$$
$$D_{AV}(\mu m) = 1.87 + 0.014 C_M \tag{11}$$

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INSTALLATION FOR THE CRUDE OIL PURIFICATION FROM ADMIXTURES BY ELECTROMAGNETIC FIELDS, DRIVING BY ANALYZER ON THE BASE OF PROTON MAGNETIC RESONANCE RELAXOMETRY

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Annotation. Digital oil deposit with the control of oil-mining, preparation and transportation of crude oil by automated instrument-program complexes actual and expedient because it gives increase of oil extraction 10-25% and reduce energetic losses on 8%. Express-control of the purification of crude from such admixtures as water in oil, asphaltenes and tars, paraffins, etc is actual. Was described the installation for the crude oil purification from admixtures by electromagnetic fields, program and express-control methods of the process driving by analyzer on the base of proton magnetic resonance relaxometry by relaxometer of proton magnetic resonance (PMR), realizing the measurements of the PMR-relaxation parameters.

Keywords: express-control, installation, purification, relaxometer, proton, magnetic, resonance.

Digital oil deposit with the control of oil-mining, preparation and transportation of crude oil by automated instrument-program complexes actual and expedient because it gives increase of oil extraction 10-25% and reduce energetic losses on 8% [1,2]. Express-control of the purification of crude from such admixtures as water in oil, salts, sukfur, asphaltenes and tars, paraffins, etc is also actual for effective driving of the deposit equipment.

Oil preparation include the thermal treatment of the crude oil, mixing

with reagents and removing of the emulsified water with admixtures in the electric field. For this purpose are used electric dehydrators [3]. But the process cann't ensure sufficient preparation of the oil by GOST P 51858-2002 and for super viscose oil by GOST 31378-2009 and so it's necessary additional purification of oils on the oil converting enterprises. Reason of this lack is not sufficient control of physic-chemical properties of oil, so lack of opportunities for optimizing of purification process. It can be done by instrument-program complexes using elaborated by us methods of express-control of liquid characteristics through proton magnetic resonance (PMR)-parameters.

The aim of the paper is the description of the technology processes of oil purification from admixtures (water, salts and sulfur) with simultaneous control of oil properties by instrumental-programm complex (IPC) using elaborated methods. We proposed the technology of the admixtures removing in the installation with rotating magnetic and not uniform electric fields with driving of the installation using data, obtained by express-control of the oil properties (water, metal salts, sulfur, density and viscosity) by IPC on the base of proton magnetic resonance relaxometry. It is important, that technologies can be realized in the compact automated installation in the conditions of the restricted space of the oil deposition and sea oil-mining platforms. Was elaborated testing grounds, on which realized control oil refining of the crude oil from water, salts and sulfur.

Interactions between droplets include several forces, acting on water droplets:

a) Dipole-dipole interactions appear between polarized droplets, attracting them to each other by charged ends by the force, proportional to:

$$F_D = (6 (| \alpha |)^2 E_o^2 \varepsilon)/r^4, \tag{1}$$

Where polarization is defined by equation:

$$\alpha = r_o^3 (\xi - 1)/(\xi + 2), \tag{2}$$

where r_o – radius of the droplet, $\xi = \varepsilon_o/\varepsilon$, ε_o, ε - dielectric permeability of disperse phase and of emulsion correspondingly.

High E_o is undesirable to use, because there appear chains of droplets between electrodes with high current conductivity 10^{-4} - 10^{-6} (sm/cm), which decrease electric field. That's why only electric fields $E_0 <$ 2-3 кV/cm are used for demulsification of crude oil.

b) Droplets in emulsions contact with electrode and acquire charge:

$$q = 1,64 E r_o^2 \tag{3}$$

and then with the force:

$$F \approx 1{,}37E_o{}^2 r_o{}^2 \varepsilon_{cp} = 0{,}835 \; qE_o \qquad (4)$$

repulse from electrode.

c) Forces of gradient grad$E$ of the non uniform electric fields:

$$\boldsymbol{F}_E = 2\pi\varepsilon_o(\varepsilon-1)ER^3 \mathrm{grad}\boldsymbol{E}^2/(\varepsilon+2), \qquad (5)$$

which compel droplets to move to the point of maximal quantity of E electric field.

As it is seen from eq.1, there exist dependence of F_D (through polarization α) from droplets radius ro, i.e. we must consider droplets diameters distribution influence. It can be determined through PMR-parameters with relation for D_{AV} from T_{1A} (18 experimental points) with correlation coefficients $R^2 = 0.95$ for DAV is presented at fig.1.

Can be used equations for mean $D_{av} = \sum N_i D_i / \sum N_i$ maximal Dmax and Slauter (volume/square) diameters $D_{3/2} = \sum N_i D_i{}^3 / \sum N_i D_i{}^2$:

$$D_{AV}(\mu m) = 0.164\exp(2.84 \cdot T_{1O} \,(\sec)) \qquad (6)$$

$$D_{maxI} = 0{,}32 \cdot \exp(1{,}37 \cdot T_{1O}) \qquad (7)$$

$$D_{3/2} = 4{,}2 \cdot (T_{1O})^{4,27} \qquad (8)$$

where T_{1O} – relaxation time of oil protons.
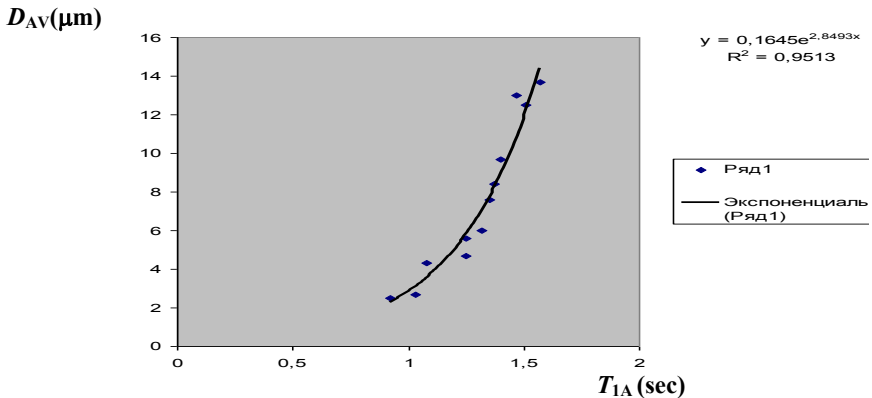
Figure 1. Correlation between $D_{CA}(\mu m)$ and T_{1A} (sec)

Was also proposed the device for formation of the oil-water emulsions, which are used for emulsion samples preparation derive their correlations from PMR-parameters. Was established, that at critical electric fields E the needle works as a generator of the little droplets with mean diameter D of the droplets depends from E_o by equation:

$$D\,(\mu m) \approx 13.45 + 14.5/E_o(kV/cm) \tag{9}.$$

On the fig. 2 is presented microfoto of 50% (left) and 4% emulsions (right), produced by device.
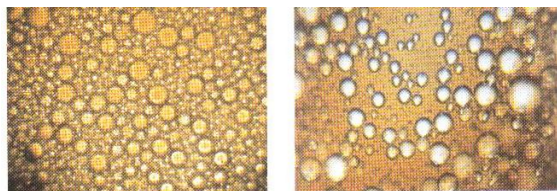
Figure 2. Microfoto of 50% (left) and 4% emulsions (right)

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ON ONE CAUCHY PROBLEM FOR DEGENERATE EQUATIONS FOR A REACTIVE MIXTURE OF GASES

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Abstract. This article investigates a system of nonlinear differential equations describing a one-dimensional flow of a reacting gas mixture in a porous medium. An unlimited area is considered. Moreover, the sought functions at the initial moment of time tend to zero, which leads to the degeneration of the equations. The existence of a generalized solution is proved by the regularization method.
Keywords: speed, density, temperature, magnetic field, electric field, generalized solution, a priori estimates, existence.

The system of equations describing the flow of a reacting gas mixture with allowance for the porosity of the medium in mass Lagrangian coordinates has the form [1]:

$$\frac{\partial \rho}{\partial t} + \rho^2 \frac{\partial u}{\partial x} = 0,$$

$$\frac{\partial c}{\partial t} = \chi \frac{\partial}{\partial x}\left(\rho \frac{\partial c}{\partial x}\right) - c\,g,$$

$$\frac{\partial u}{\partial t} = \mu \frac{\partial}{\partial x}\left(\rho \frac{\partial u}{\partial x}\right) - r \frac{\partial}{\partial x}(\rho \theta) - \beta(x)|u|^{\alpha} u,$$

$$\frac{\partial \theta}{\partial t} = \lambda \frac{\partial}{\partial x}\left(\rho \frac{\partial \theta}{\partial x}\right) + \frac{\partial}{\partial x}\left(\nu \rho^{3/2}\,\theta \frac{\partial c}{\partial x}\right) - r\rho\,\theta \frac{\partial u}{\partial x} + \mu\,\rho\left(\frac{\partial u}{\partial x}\right)^2 + \delta\,c\,g. \quad (1)$$

Here u, θ, ρ, c – respectively, the velocity, absolute temperature, density and mass concentration of the components are the required functions of the spatial variable x, $x \in R = (-\infty; \infty)$ and time t, $t \in [0,T]$, $0 < T < \infty$; μ, r, λ, ν, χ – positive constants, which in what follows, for simplicity, will be assumed to be equal to one; $\beta(x)$ – coefficient of permeability - continuous, not negative, limited function and .

$$\int_{-\infty}^{\infty} \beta(x)dx \le C; \quad \int_{-\infty}^{\infty} (\beta(x))^{2/(2-3\alpha)}dx \le C; \quad 0 \le \alpha < 2/3.$$

At time $t = 0$ the values of the functions ρ, u, θ, c are assumed to be known:

$$\rho\big|_{t=0} = \rho^0(x), \ u\big|_{t=0} = u_0(x), \ \theta\big|_{t=0} = \theta_0(x), \ c\big|_{t=0} = c_0(x), \ x \in R, \quad (2)$$

and $(\rho^0, u_0, \theta_0, c_0)$ - continuous, $0 \le c_0 \le 1$, (ρ^0, θ_0) - bounded, non-negative functions and have zero limits at infinity:

$$\lim_{|x| \to \infty} \rho^0(x) = 0, \ \lim_{|x| \to \infty} \theta_0(x) = 0, \ \lim_{|x| \to \infty} u_0(x) = 0, \ \lim_{|x| \to \infty} c_0(x) = 0. \quad (3)$$

Definition. *A generalized solution to problem (1) - (3) is a set of functions* (u, ρ, θ, c), *with the properties*

$$\left(u_x, \theta_x, c_x, \rho, \rho_x, \rho_t\right) \in L_\infty\left(0, T; L_2(R)\right),$$
$$\left(u_t, \ \theta_t, c_t, \sqrt{\rho^0} u_{xx}, \sqrt{\rho^0} \theta_{xx}, \sqrt{\rho^0} c_{xx}\right) \in L_2(\Pi),$$

and satisfying equations (1) almost everywhere in $\Pi = R \times (0, T)$.

Theorem. *Let the initial data (2) satisfy the conditions:*

$$\left(\rho^0, \ u_0, \ \theta_0, c_0\right) \in W_2^1(R), \ (c_0, \ \theta_0) \in L_1(R), \ \left(\rho_x^0\right)^2 < C \rho^0(x), \ x \in R,$$

$$\frac{\beta(x)}{\rho^0} \le C \ \frac{\rho_x^0}{\rho^0} \in L_2(R), \ \int_A^{B} \int_x^{x+1} \left(\rho_\xi^0\right)^2 d\xi dx < C \quad \forall A, B \in R, \ A < B.$$

A function $g(\rho, c, \theta) = \rho \eta(c, \theta)$, *where* $\eta(c, \theta)$ *is assumed to be continuous, non-negative in any compact domain of its arguments, and satisfying the Lipschitz condition with respect to* $\theta^{1/2}$.

Then, in a strip $\Pi = R \times (0, T)$ with an arbitrary finite height T, $0 < T < \infty$ there exists a generalized solution to problem (1) - (3).

We prove the theorem formulated by the regularization method. To do this, instead of the set problem, we will consider a regularized problem:

$$\frac{\partial \rho_\varepsilon}{\partial t} + \rho_\varepsilon^2 \frac{\partial u_\varepsilon}{\partial x} = 0,$$

$$\frac{\partial c_\varepsilon}{\partial t} = \chi \frac{\partial}{\partial x}\left(\rho_\varepsilon \frac{\partial c_\varepsilon}{\partial x}\right) - c_\varepsilon \ g, \quad (4)$$

$$\frac{\partial u_\varepsilon}{\partial t} = \mu \frac{\partial}{\partial x}\left(\rho_\varepsilon \frac{\partial u_\varepsilon}{\partial x}\right) - r \frac{\partial}{\partial x}(\rho_\varepsilon \theta_\varepsilon) - \beta(x)|u_\varepsilon|^\alpha u_\varepsilon,$$

$$\frac{\partial \theta_\varepsilon}{\partial t} = \lambda \frac{\partial}{\partial x}\left(\rho_\varepsilon \frac{\partial \theta_\varepsilon}{\partial x}\right) + v \frac{\partial}{\partial x}\left(\rho_\varepsilon^{3/2} \theta_\varepsilon \frac{\partial c_\varepsilon}{\partial x}\right) - r\rho_\varepsilon \theta_\varepsilon \frac{\partial u_\varepsilon}{\partial x} + \mu \rho_\varepsilon\left(\frac{\partial u_\varepsilon}{\partial x}\right)^2 + \delta \ c_\varepsilon g,$$

$$\rho_\varepsilon \big|_{t=0} = \rho_\varepsilon^0(x), \; u_\varepsilon \big|_{t=0} = u_0(x), \; \theta_\varepsilon \big|_{t=0} = \theta_0(x), \; c_\varepsilon \big|_{t=0} = c_0(x)$$

$$0 < \varepsilon \le \rho_\varepsilon^0(x) \le M, \; 0 \le \theta_0(x) \le M, \; 0 \le c_0(x) \le 1,$$

(5)

where $\displaystyle\lim_{|x|\to\infty} \rho_\varepsilon^0(x) = \varepsilon, \; \rho_\varepsilon^0 = \rho^0 + \varepsilon,$

also $\displaystyle\lim_{\varepsilon\to 0} \left\| \rho_\varepsilon^0 - \rho^0 \right\|_{W_2^1(K)} = 0,$

here K - is an arbitrary compact set in R. For a regularized problem, the existence and uniqueness theorem for a local solution follows from [2, 3]. In what follows, the subscript ε will be omitted. Our goal is to find estimates that are uniform in ε and to pass to the limit in ε Assume $d = 1$. In what follows C, N_i will denote positive constants independent of ε.

The first equation of system (4)

$$\rho \frac{\partial u}{\partial x} = -\frac{\partial}{\partial t} \ln \rho$$

substitute into the second equation with subsequent integration over t:

$$\frac{\partial}{\partial x}\left[\ln \rho(x,t) + r \int_0^t \rho(x,\tau)\theta(x,\tau)d\tau \right] = \frac{\partial}{\partial x} \ln \rho^0(x) - u(x,t) + u_0(x) - \int_0^t \beta(x)|u|^\alpha \, u \, d\tau.$$

Secondary integration over x with a fixed t from point x_0 to arbitrary x and subsequent potentiation gives the equality:

$$\rho(x,t)\exp\left\{ r \int_0^t \rho(x,\tau)\theta(x,\tau)d\tau \right\} = \rho^0(x)Y(t,x_0)B(x,t)K^{-1}(x,t),$$

(6)

where

$$Y(t,x_0) = \frac{\rho(x_0,t)}{\rho^0(x_0)}\exp\left\{ r\int_0^t \rho(x_0,\tau)\theta(x_0,\tau)d\tau \right\},$$

$$B(x,t) = \exp \int_{x_0}^x \left[u_0(\xi) - u(\xi,t) \right]d\xi, \qquad K(x,t) = \exp\int_0^t\int_0^x \beta(x)|u|^\alpha \, u \, d\xi d\tau.$$

Arbitrariness remained in the choice of point x_0.
We multiply both sides of (6) by $r\theta(x,t)$ and integrate over t:

$$\exp\left\{ r\int_0^t \rho(x,\tau)\theta(x,\tau)d\tau \right\} = 1 + r\rho^0(x)\int_0^t Y(\tau,x_0)B(x,\tau)K^{-1}(x,\tau)\theta(x,\tau)d\tau.$$

Returning to (6), we find

$$\rho(x,t) = \rho^0(x)Y(t,x_0)B(x,t)K^{-1}(x,t)\times$$

$$\times\left[1 + r\rho^0(x)\int_0^t Y(t,x_0)B(x,\tau)K^{-1}(x,\tau)\theta(x,\tau)d\tau \right]^{-1}.$$

(7)

To derive the necessary estimates, we split the R axis and, accordingly, the Π strip into finite segments and rectangles with the following properties:

$$R = \bigcup_{N=-\infty}^{\infty} \overline{\Omega}_N, \quad \Pi = \bigcup_{N=-\infty}^{\infty} \overline{Q}_N, \quad \Omega_i \cap \Omega_j = \varnothing, \; i \neq j,$$

$$\Omega_N = \{x \mid A_N < x < A_{N+1}\}, \; Q_N = \Omega_N \times (0,T), \; N = 0,\pm 1, \pm 2, ..., \; \sup_k |A_{k+1} - A_k| < \infty.$$

We will study the relationship between the required functions on each Q_N. Let's use the arbitrariness for point x_0. In what follows, we will every-where assume that the point x_0 is chosen in the corresponding Ω_N.

Under the conditions of the theorem, the inequality

$$N_1^{-1} \leq B(x,t) \leq N_1 < \infty, \quad (x,t) \in Q_N. \tag{8}$$

Multiplying the third equation of system (4) by u and adding it with the second and fourth, we obtain

$$\frac{\partial \omega}{\partial t} = \mu \frac{\partial}{\partial x}\left(\rho \frac{\partial \omega}{\partial x}\right) + (\lambda - \mu)\frac{\partial}{\partial x}\left(\rho \frac{\partial \theta}{\partial x}\right) + (\chi - \mu)\frac{\partial}{\partial x}\left(\rho \frac{\partial c}{\partial x}\right) -$$
$$- r\frac{\partial}{\partial x}(\rho\theta u) + v\frac{\partial}{\partial x}\left(\rho^{3/2}\theta\frac{\partial c}{\partial x}\right) - \beta(x)|u|^\alpha u^2, \tag{9}$$

where $\omega(x,t) = \dfrac{1}{2}u^2(x,t) + \theta(x,t) + c(x,t)$.

The properties of solutions for the regularized problem imply the non-negativity of θ, c. Integrating the last equality over R and over t, we have the estimates:

$$\|u(t)\|^2 + \|\theta(t)\|_{1,R} + \|c(t)\|_{1,R} \leq N_2, \tag{10}$$

$$\int_0^T\int \beta(x)|u|^\alpha u^2 dxdt \leq N_3. \tag{11}$$

Hence, statement (8) follows.

Under the conditions of the theorem, the estimate

$$N_2^{-1} \leq K(x,t) \leq N_2 < \infty, \quad (x,t) \in Q_N. \tag{11}$$

Applying Hölder's inequality, (10), conditions for $\beta(x)$,, we obtain

$$\left|\int_0^t\int_0^x \beta(\xi)|u|^\alpha u\,(\xi,\tau)d\xi\,d\tau\right| \leq \int_0^t\int_{A_N}^{A_{N+1}} \beta(x)|u|^{\alpha+1}dxd\tau \leq$$

$$\leq \int\limits_0^t \left(\int\limits_{A_N}^{A_{N+1}} u^2 dx \right)^{\frac{1+\alpha}{2}} \left(\int\limits_{A_N}^{A_{N+1}} \beta^{\frac{2}{1-\alpha}}(x) dx \right)^{\frac{1-\alpha}{2}} + C \leq C.$$

This implies the double inequality (11).

Under the conditions of the theorem, for any $A, B \in R$,, where $A < B$ the following estimates are true:

$$B - A - C_0 \sqrt{B-A} \leq \int\limits_A^B \int\limits_x^{x+1} \frac{\rho^0(\xi)}{\rho(\xi,t)} d\xi\, dx \leq B - A + C_0 \sqrt{B-A}. \qquad (12)$$

The proof is similar to [4].

Under the conditions of the theorem, the estimate

$$N_3^{-1} \leq Y(t,x_0) \leq N_3 < \infty, \quad \forall (x_0,t) \in Q_N.$$

The proof follows from representation (7) and estimates (12).

We multiply the second equation of system (4) by $c(x,t)$. After integration over $x \in R$ and over $t \in [0,T]$, taking into account the conditions of the theorem, we conclude

$$\max_{0 \leq t \leq T} \| c(t) \|^2 + \int\limits_0^T \int\int \left(\rho\, c_x^2 + c^2 g \right) dx dt \leq N_4.$$

Let $f(x,t)$ be a continuous function. We denote

$$M_f^N(t) = \max_{x \in \Omega_N} f(x,t), \quad \overline{M}_f(t) = \max_{x \in R} f(x,t),$$

$$m_f^N(t) = \min_{x \in \Omega_N} f(x,t), \quad \overline{m}_f(t) = \min_{x \in R} f(x,t).$$

Under the conditions of the theorem, the following estimates hold

$$\overline{M}_{\rho/\rho^0}(t) \leq N_5, \qquad M_{\rho^0/\rho}(t) \leq N_6 \left[1 + \int\limits_0^t M_{\rho^0 \theta}(\tau) d\tau \right]. \qquad (13)$$

The proof of (13) follows from the representation (7).

Let's get some more auxiliary relations for temperature. We put

$$I_0^N(t) = \int\limits_{\Omega_N} \rho^0(x)\theta_x^2(x,t) dx, \quad I_1^N(t) = \int\limits_{\Omega_N} \rho(x,t)\theta_x^2(x,t) dx, \quad \bar{I}_1(t) = \int \rho(x,t)\theta_x^2(x,t) dx,$$

$$I_{01}^N(t) = \int\limits_0^t I_0^N(\tau) d\tau, \quad I_{11}^N(t) = \int\limits_0^t I_1^N(\tau) d\tau, \quad \bar{I}_{11}(t) = \int\limits_0^t \bar{I}_1(\tau) d\tau,$$

where $N = 0, \pm 1, \pm 2, \dots$ For convenience, in what follows, the subscript *N* will be omitted.

Under the conditions of the theorem, the following inequalities hold

$$M_{\rho^0/\rho}(t) \leq C\, I_{11}^{1/2} + C, \quad M_{\rho^0 \theta^2}(t) \leq \gamma\, I_1 + C_\gamma I_{11} + C, \qquad (14)$$

where γ – an arbitrary positive number.

The proof is similar to [4].

From (14) the estimates follow:

$$\overline{M}_{\rho^0/\rho}(t) \le C\,\bar{I}_{11}^{1/2} + C, \quad \overline{M}_{\rho^0\theta^2}(t) \le \gamma\,\bar{I}_1 + C_\gamma\bar{I}_{11} + C. \tag{15}$$

The second equation of system (4) implies the estimate: $0 \le c \le 1.$.

We multiply the second equation of system (4) by $c(x,t)$. After integration over $x \in R$ and over $t \in [0,T]$,, taking into account the conditions of the theorem, we conclude

$$\max_{0 \le t \le T} \| c(t) \|^2 + \int_0^T\!\!\int \left(\rho\, c_x^2 + c^2 g \right) dx dt \le N_7. \tag{16}$$

We multiply the second equation of system (4) by $(\rho c_x)_x$ and integrate over R:

$$\frac{1}{2}\frac{d}{dt}\int \rho c_x^2 dx + \int \left((\rho c_x)_x \right)^2 dx = -\frac{1}{2}\int \rho^2 c_x^2 u_x dx + \int cg(\rho c_x)_x dx = I_1 + I_2. \tag{17}$$

Using integration by parts, Young's inequalities, embeddings, the Lipschitz property of the function $g(\rho,c,\theta)$ with respect to $\theta^{1/2}$ and (10), we estimate the integrals on the right-hand side of (17). We integrate the inequality obtained from (17) over t and pass to the limit as $n \to \infty$. As a result, we derive

$$\int \rho\, c_x^2 dx + \int_0^t\!\!\int (\rho\, c_x)_x^2 dx d\tau \le N_8, \quad \forall t \in [0,T]. \tag{18}$$

Under the conditions of the theorem, the estimate

$$M_{\rho^0/\rho} \le N_9, \quad \forall t \in [0,T]. \tag{19}$$

Let us prove (19). In view of estimates (15), it suffices to obtain the boundedness of $\bar{I}_{11}$. Let's prove it. We multiply equation (9) by $\omega(x,t)$ and integrate over R:

$$\frac{1}{2}\frac{d}{dt}\| \omega \|^2 + \mu\int \rho\omega_x^2\,dx + (\lambda - \mu)\int \rho\theta_x\omega_x\,dx + \int \beta(x)|u|^\alpha u^2\omega\,dx =$$
$$= r\int u\,\rho\theta\,\omega_x\,dx - v\int \rho^{3/2}\theta\,c_x\omega_x\,dx - (\chi - \mu)\int \rho\,c_x\omega_x\,dx. \tag{20}$$

According to the Young and Cauchy inequalities, the right-hand side does not exceed the value

$$\varepsilon\int \rho\omega_x^2\,dx + C_\varepsilon\left(\int \rho\,\theta^2 u^2\,dx + \int \rho^2\theta^2 c_x^2 dx + \int \rho\,c_x^2 dx + 1 \right),$$

where $\varepsilon > 0$ - is an arbitrary number. Arguing further similarly to [2], by the definition of the function $\omega(x,t)$ we obtain at $\varepsilon < \dfrac{\lambda}{2}$:

$$(\mu - \varepsilon)\omega_x^2 + (\lambda - \mu)\theta_x\omega_x \ge (\lambda - 2\varepsilon)\theta_x^2 - 2\left[\frac{1}{4}\varepsilon^{-1}(\mu + \lambda)^2 + \lambda + 2\mu + 2\varepsilon \right]\left(u^2 u_x^2 + c_x^2 \right)$$

Therefore, taking $\varepsilon = \min\left(\dfrac{1}{8}, \dfrac{\lambda}{8}\right)$, from (20) taking into account (13), (18), we obtain

$$\frac{d}{dt}\|\omega\|^2 + \frac{3\lambda}{2}\int \rho\theta_x^2\, dx \le C_1\left(\int \rho\theta^2 u^2\, dx + \int \rho u^2 u_x^2\, dx + \int \rho^2\theta^2 c_x^2\, dx + 1\right). \quad (21)$$

If the momentum equation of system (4) is multiplied by $u^3(x,t)$ and integrated over R, then we arrive at the relation

$$\frac{1}{4}\frac{d}{dt}\|u\|_{4,R}^4 + 3\int \rho u^2 u_x^2\, dx + \int \beta(x)|u|^\alpha u^4\, dx = $$
$$= 3\int \rho\theta u^2 u_x\, dx \le \frac{3}{2}\int \rho u^2 u_x^2\, dx + \frac{3}{2}\int \rho\theta^2 u^2\, dx. \quad (22)$$

Multiplying (22) by $\dfrac{2}{3}C_1$ and adding with (21), taking into account (10), (13), we conclude

$$\frac{d}{dt}\left(\|\omega\|^2 + \alpha\|u\|_{4,R}^4 + \frac{3\lambda}{2}\bar{I}_{11}\right) \le C_2\, \overline{M}_{\rho^0\theta^2} + C_3, \qquad \alpha = \frac{1}{6}C_1.$$

Taking into account (15), we have the inequality:

$$\frac{d}{dt}\left(\|\omega\|^2 + \alpha\|u\|_{4,R}^4\right) + \frac{3\lambda}{2}\bar{I}_1 \le \gamma\,\bar{I}_1 + C_\gamma\bar{I}_{11} + C.$$

Choosing γ mall enough and applying Gronwall's inequality, we obtain the boundedness of the function $\bar{I}_{11}$, and hence the estimate (19).

Using the estimates obtained above, it is easy to obtain the estimates:

$$\max_{0\le t\le T}\|\theta(t)\|^2 + \int_0^T \|\sqrt{\rho}\,\theta_x\|^2\, dt \le N_{10}, \qquad \int_0^T\left(\overline{M}_{\rho^0\theta^2}(t) + \overline{M}_{\rho^0\theta}(t)\right)dt \le N_{11}.$$

$$\int_0^T\!\!\int \beta(x)|u|^\alpha u^4\, dxdt \le N_{12}.$$

From the third equation of system (4), after multiplication by $u(x,t)$, integration over (x,t) and some transformations, the estimates are derived

$$\max_{0\le t\le T}\|u(t)\|^2 + \int_0^T\|\sqrt{\rho}\,u_x\|^2\, dt + \int_0^T\!\!\int \beta(x)|u|^\alpha u^2 dxdt \le N_{13}.$$

Under the conditions of the theorem, the inequality

$$\max_{0\le t\le T}\|\rho_x(t)\rho^{-1}(t)\| \le N_{14}. \quad (23)$$

Proof. Differentiating (7) with respect to x, we have [2]:

$$\rho_x(x,t)/\rho(x,t) = \bar{A}(x,t) + $$

$$+ \rho(x,t)B^{-1}(x,t)Y^{-1}(t,x_0)\left\{\frac{d}{dx}\left(\frac{1}{\rho^0(x)}\right) - \int_0^t B(x,\tau)Y(\tau,x_0)\left(\frac{\partial\theta}{\partial x} + \theta A\right)(x,\tau)d\tau\right\},$$

where $A(x,t) = u_0(x) - u(x,t)$.

Take norms in $L_2(R)$ from both sides. Taking into account the conditions of the theorem, (13), (16), (18), (19), we estimate the right-hand side. After some transformations, we derive estimate (23).

Taking into account (13), (16), (18), (19), from (17) and the second equation of system (4) it follows

$$\max_{0 \le t \le T} \| c_x(t) \|^2 + \int_0^T \left(\left\| \sqrt{\rho^0} c_{xx}(t) \right\|^2 + \| c_t(t) \|^2 \right) dt \le N_{15}.$$

Under the conditions of the theorem, the inequality

$$\max_{0 \le t \le T} \| u_x(t) \|^2 + \int_0^T \left(\left\| \sqrt{\rho^0} u_{xx}(t) \right\|^2 + \| u_t(t) \|^2 \right) dt \le N_{16}. \qquad (24)$$

Let us write down the momentum equation in expanded form

$$\frac{\partial u}{\partial t} = \rho \frac{\partial^2 u}{\partial x^2} + \frac{\partial \rho}{\partial x} \frac{\partial u}{\partial x} - \frac{\partial \rho}{\partial x} \theta - \rho \frac{\partial \theta}{\partial x} - \beta(x) |u|^\alpha u$$

and, multiplying by u_{xx}, we integrate over R.

$$\frac{1}{2} \frac{d}{dt} \| u_x \|^2 + \int \rho u_{xx}^2 dx = \int \left(\rho_x \theta u_{xx} + \rho \theta_x u_{xx} - \rho_x u_x u_{xx} - \beta(x) |u|^\alpha u u_{xx} \right) dx. \qquad (25)$$

Let us estimate the integrals on the right-hand side of (25), taking into account (13), (19):

$$I_1 = \int | \rho_x \theta u_{xx} | dx \le \left(\int \frac{\rho_x^2}{\rho^2} dx \right)^{1/2} \left(\int \frac{\rho^0}{\rho^0} \rho^2 \theta^2 u_{xx}^2 dx \right)^{1/2} \le \delta_1 \int \rho u_{xx}^2 dx + C_{\delta_1} \overline{M}_{\rho^0 \theta^2},$$

$$I_2 = \int | \rho \theta_x u_{xx} | dx \le \delta_2 \int \rho u_{xx}^2 dx + C_{\delta_2} \int \rho \theta_x^2 dx,$$

$$I_3 = \int | \rho_x u_x u_{xx} | dx \le (\delta_3 + C \delta_4) \int \rho u_{xx}^2 dx + C \int \rho u_x^2 dx,$$

$$I_4 = \int | \beta(x) |u|^\alpha u u_{xx} | dx \le \left(\int \rho u_{xx}^2 dx \right)^{1/2} \left(\int \frac{\rho^0}{\rho} \frac{\beta(x)}{\rho^0} \beta(x) |u|^{2(\alpha+1)} dx \right)^{1/2} \le$$

$$\le \delta_5 \int \rho u_{xx}^2 dx + \frac{1}{2} C_{\delta 5} \int \beta(x) |u|^\alpha u^4 dx + \frac{1}{2} C_{\delta 5} \left(\int |u|^2 dx \right)^{3\alpha/2} \left(\int (\beta(x))^{\frac{2}{2-3\alpha}} dx \right)^{(2-3\alpha)/2} \le$$

$$\le \delta_5 \int \rho u_{xx}^2 dx + \frac{1}{2} C_{\delta 5} \int \beta(x) |u|^\alpha u^4 dx + C.$$

As a result, from (25) we find the inequality

$$\frac{1}{2} \frac{d}{dt} \| u_x \|^2 + \int \rho u_{xx}^2 dx \le$$

$$\le (\delta_1 + \delta_2 + \delta_3 + C \delta_4 + \delta_5) \int \rho u_{xx}^2 dx + C \left[\int \rho u_x^2 dx + \int \rho \theta_x^2 dx + \overline{M}_{\rho^0 \theta^2} + 1 \right].$$

Choosing $\delta_i > 0 (i = \overline{1,4})$ from condition $\delta_1 + \delta_2 + \delta_3 + C \delta_4 + \delta_5 < 1$ and in-

tegrating the last inequality over *t* taking into account the previously obtained estimates, we conclude

$$\max_{0 \le t \le T} \| u_x(t) \|^2 + \iint\limits_{0}^{T} \rho \, u_{xx}^2 dx \, dt \le N_{17}.$$

Using the momentum equation, we derive statement (24).

Multiplying the heat equation of system (4) by θ_{xx}, after some transformations, one can obtain the estimate

$$\max_{0 \le t \le T} \| \theta_x \|^2 + \int\limits_{0}^{T} \left(\left\| \sqrt{\rho^0} \theta_{xx} \right\|^2 + \| \theta_t \|^2 \right) dt \le N_{18}.$$

The proof of the passage to the limit is carried out in the same way as in items [2, 4].

The theorem is completely proved.

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THE RESEARCH OF THE PROSPECTS FOR THE USE OF GEOGRAPHIC INFORMATION SYSTEMS IN URBAN PLANNING AND CADASTRAL ACTIVITIES

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Abstract. In the article, the authors considered the theoretical provisions of the application of geographic information systems in cadastral and urban planning activities, analyzed the legislative framework that regulates urban planning and cadastral activities, providing cartographic and informational information. The process of state cadastral registration and state registration of rights, urban planning zoning of the territory is described in detail, the most widespread violations in the establishment of territorial zones are revealed. The experience of using the functionality of geographic information systems has been implemented, the stages of checking for violations of semantic and graphic data have been considered, and a method for eliminating errors has been developed in order to register land plots with state cadastral registration. The technique of applying geoinformation systems in practice in urban planning and cadastral activities has been improved.

Keywords: geographic information systems, cadastral activities, urban planning activities, land plots, state registration of rights, state cadastral registration, territorial zones, land use and development rules.

Introduction

With the modern development of geographic information technologies, graphic information systems (hereinafter – GIS) allow for a comprehensive analysis and accounting of geographic spatial data, modeling and visualization of the analyzed indicators when creating urban planning and cadastral documentation.

The relevance of the study is due to the need to improve the methodology for using GIS technologies in urban planning and cadastral activities.

In the relevant domestic publications, including the works of Mityagin S.D., Skachkova M.E., Raklov V.P., Asanov V.L. this issue has not been fully worked out, which motivated the research, the main results of which are presented in this article [1-4].

Purpose of the study – to improving the methods of using GIS technologies in urban planning and cadastral activities.

In the course of the study, the following tasks were solved: a) the provisions of the legal regulation of the creation and operation of geographic information systems in cadastral and urban planning activities were analyzed; b) a comprehensive analysis of the application of GIS technologies was carried out; c) proposals have been developed for the practical implementation of GIS technologies in urban planning and cadastral activities.

Materials and methods

In modern scientific and specialized literature, this issue is just beginning to be developed, as evidenced by the work of Russian scientists Mityagin S.D., Skachkova M.E., Raklov V.P., Asanov V.L. et al. [1-4].

The need to improve the methodology for using GIS technologies in urban construction and cadastral activities has been around for a long time. It should also be noted that there is no detailed analysis of the application of GIS technologies in these areas.

Note that inventory management is based on a number of isolated stages linked into a single technological chain. The main ones are: determination of the physical state of real estate objects, their identification and description by the cadastral registration authority, registration of rights to real estate and appraisal.

State cadastral registration (hereinafter – SCR), registration of rights to real estate and transactions with real estate, state land supervision are under the jurisdiction of the FSBI "FCC Rosreestr". This cadastral registration body provides the procedure for registering and issuing rights to real estate, issues information about the real estate object entered in the database of the Unified State Register of Real Estate (hereinafter – USRN), carries out a set of works for the state cadastral valuation, etc.

At the same time, a real estate object is an existing land and all material property, which has its own functional purpose. The general signs of immovability include: stationarity, durability and materiality.

The Civil Code of the Russian Federation, Articles 130, 132, defines objects related to real estate. These include: land plots, subsoil plots, isolated water bodies, buildings, structures, structures, perennial plantings, aircraft, sea and inland navigation vessels, space objects, an enterprise as a property complex.

SCR is carried out in relation to newly formed and previously accounted areas. The accounting procedure allows you to confirm the existence of a property with certain characteristics and fix its geographic location.

The cadastral registration authority, in the event of a positive decision on the implementation of cadastral registration, is obliged to issue to the applicant, depending on the cadastral actions: 1) register extract of the property — when registering an object; 2) register extract containing new information about the property — taking into account the changes that have occurred; 3) register extract, which contains data on the part of the real estate object, which is subject to the restriction (encumbrance) of real rights — when accounting for part of the property; 4) register extract containing information on the termination of the existence of an immovable object — when it is removed from the register [1,3].

When deciding to refuse to be listed on SCR, the body for registration of rights and cadastral registration could reveal the following violations:

• the statement, form and content of the document do not meet the requirements of the legislation of the Russian Federation;

• landline plan, technical plan or survey report certified by the signature of a person who is not a cadastral engineer;

• an inappropriate person applied for cadastral registration;

• the period for suspending the implementation of cadastral registration has expired and the circumstances that served as the basis for the decision to suspend have not been eliminated;

• one of the boundaries of the land plot crosses the border of the municipality and the border of the settlement;

• the property, for the cadastral registration of which the application is submitted, is not an object of real estate, the cadastral registration of which is carried out in accordance with this Federal Law;

• the size of the formed land plot or land plot, which, as a result of the transformation, remains within the changed boundaries (changed land plot), will not comply with the requirements established in accordance with land legislation for the limiting (minimum or maximum) size of land plots;

• access to the formed or previously recorded land plot will not be provided, even if an easement is established.

Ownership rights and other property rights to immovable property and transactions with it are subject to state registration, with the exception of rights to aircraft and sea vessels, inland navigation vessels and space objects.

The problem of documentary and technical support for state authorities, local governments, individuals and legal entities, as well as all subjects of land relations, was solved using the information system of the Rosreestr portal, which includes information from the USRT [2,4,5].

The USRT information system was created by combining databases: the state cadastre of real estate, which includes information about the characteristics of the real estate object, and the unified state register of rights, which determines the emergence and transfer of rights to the real estate object. The elements of the USRT structure and its composition are shown in figure 1.

Figure 1. Composition of the Unified State Register of Real Estate

Public cadastral map (hereinafter - PCM), as one of the reference and information services of the portal of the Federal Cadastral Chamber of Rosreestr. The purpose of its creation is to provide users with USRT information on the territory of the Russian Federation.

With the help of PCM, the user can get background information about the property. PCM allows the user to view a variety of publicly available cadastral information about:

- units of cadastral division;
- land plots, buildings, structures, objects of unfinished construction;
- borders: the name of the bordering units of the administrative-territorial division, a list of documents regulating the passage of the border;
- subjects of the Russian Federation, municipalities, settlements;

- cartograms of the cartographic basis of the cadastre: type, name, source, date of relevance, link to the metadata card;

- territorial zones and zones with special conditions for the use of the territory: type and description of the zone, details of the document establishing the border of the zone (figure 2).
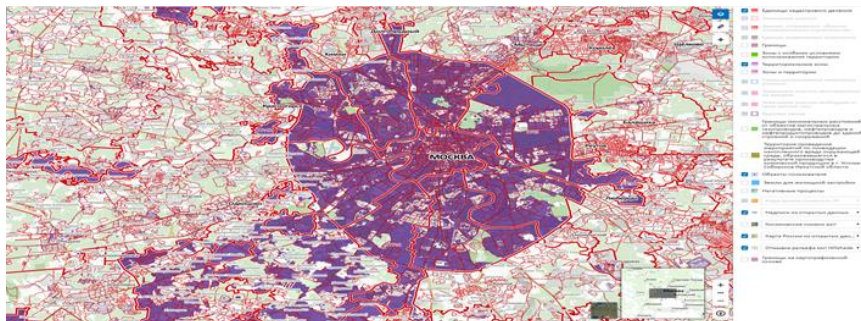

Figure 2. Public cadastral map with the applied layer of territorial zones

The public cadastral map is one of the reliable online data sources used in the preparation of urban planning and cadastral technical documentation. The information service provides electronic interaction of cadastral engineers, citizens, lawyers with government authorities [6-9].

We also note that significant attention is paid to the importance of information systems used in public administration. By order of the Government of the Russian Federation N 2378-r of December 17, 2010, the "Concept for the Development of the Geodesy and Cartography Industry until 2020 was approved".

After analyzing this document, one can single out the main direction of creating cartographic information systems - increasing the availability of cartographic and geodetic data for federal executive bodies and stakeholders to solve a number of state tasks in the field of construction, engineering surveys, territorial development, ecology, etc.

The offenses of unlawful use of GIS materials are determined by the Civil Code of the Russian Federation. Article 1259 "On objects of copyright" in clause 1 determines that "geographical and other maps, plans, sketches and plastic works related to geography and other sciences are objects of copyright."

In accordance with art. 1225 CC RF digital database is recognized as a

protected intellectual property. The right to use the cartographic work and the creator of the database are determined by the articles of CC RF № 1229. "The copyright holder can dispose of the exclusive right to a work, including distributing it through sale or other alienation, ie. transfer to other persons. Accordingly, the publication of maps, aerospace images on public access sites does not mean that they do not have a copyright holder who can, at his discretion, allow or prohibit other persons from using the result of their labor. The absence of a prohibition by law does not count as consent".

Results and discussion

The object of the study is land plots with a previously recorded status and territorial zones on the territory of the Basmanny District in Moscow.

The investigated land plots have cadastral numbers: 77:01:0003027:125, 77:03:0003026:8, 77:01:0003027:124, 77:01:0003027:57, 77:01:0003027:126, 77:01:0003027:112 and 77:01:0003027:3665.

Territorial zones with unique numbers: 77-01-02-000031 (cadastral number 77.01.1.3173), 77-04-18-000053 (cadastral number 77.03.1.2856), 77-01-02-000159. The geographic location of the objects is shown in figure 3.

Figure 3. Cadastral map of the surveyed areas and territorial zones

Each land plot (hereinafter - LP), referred to real estate, has a number of mandatory characteristics, including the boundaries of the outer contour. They are determined by establishing characteristic boundary points that are recorded in the survey plan and USRT information.

During the analysis of the topology, it was found that these land plots form an intersection with other plots and territorial zones. Territory area 77-01-02-000159 is not on SCR. The intersections of LP and territorial zones are shown in figure 4.
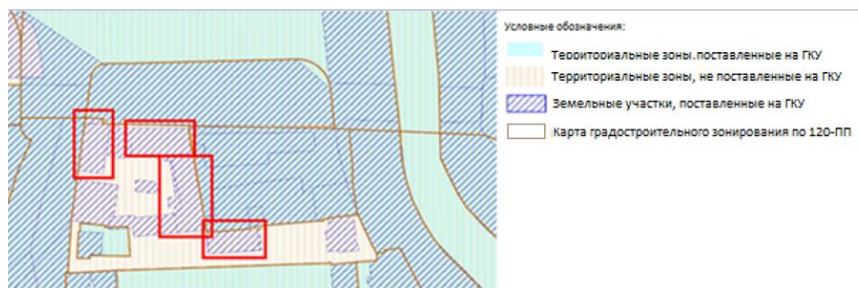

Figure 4. Areas with a crossed contour

Due to the limited volume of the article, the author could not provide complete information about the objects of research included in the USRT, such as, for example, the cadastral number, cadastral value (rubles), total area (sq. m.), Address according to the document, permitted use, date of change of information in SCR, as well as rights and restrictions on objects.

Figure 5 shows a fragment of the urban planning zoning map LP, indicating the types of permitted use located within the boundaries of the territorial zone.

Based on the provisions of clauses 3, 6 of article 11.9, clause 2 of article 83 of the Land Code of the Russian Federation, the boundaries of land plots should not cross the boundaries of municipalities and (or) the boundaries of settlements.

The boundaries of urban, rural settlements cannot cross the boundaries of municipalities or go beyond their boundaries, as well as cross the boundaries of land plots provided to citizens or legal entities.

Figure 5. Fragment of a map of urban planning zoning

The formation of a land plot with intersections does not allow to form its borders and put it on the cadastral register.

So, there are a number of violations associated with the establishment of the LUDR and the design of urban zoning maps, as well as the appearance of refusals to register land plots.

For a general geographic basis, it was decided to use the IS REON as a data source, an information system that unites a number of other geoinformation systems in Moscow and provides users with information about land plots, buildings and structures located in the city.

In the process of analyzing the objects under study, violations were identified: the boundaries of the sites intersect with the boundaries of other sites, as well as the boundaries of the territorial zones intersect with the sites.

The studied land plots were taken as the edited material.

To detect the intersections of the boundaries of land parcels on the toolbar, perform the "Check polygons" in MapInfo (fig. 6).

Figure 6. Standard tool for checking the topology of polygons in MapInfo "Check polygons"

We select the necessary objects and rules for detecting topology errors: detecting self-intersections, overlaps and voids between polygons (figure 7).
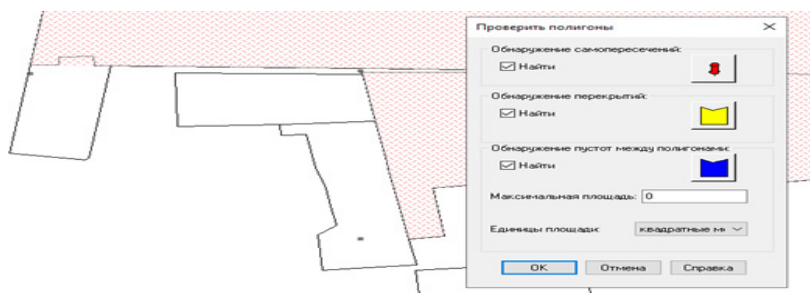
Figure 7. Window of the tool for checking the topology of polygons in MapInfo

As a result of the check, LP intersections were found. For clarity, the place of intersection is highlighted in yellow, a map legend with legend is made (fig. 8).
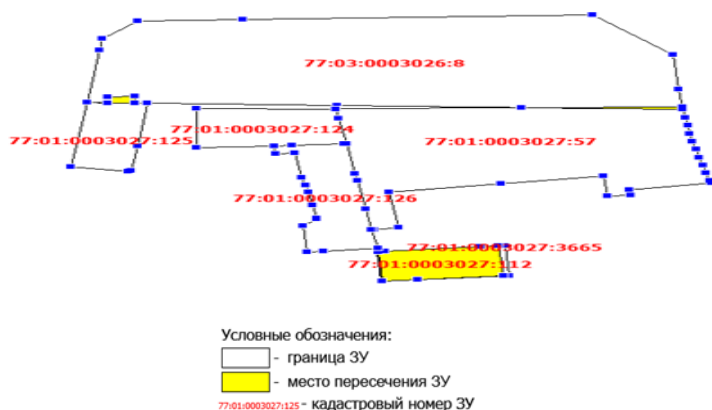

Figure 8. Map of land plots with intersections

In accordance with clauses 39, 96 of the Order of the Ministry of Economic Development of the Russian Federation of December 8, 2015 № 921 "On the approval of the form and composition of the landline plan information, requirements for its preparation" requirements, the value of the area of land plots (parts of land plots), multi-contour land plots in the landline plan is indicated in square meters rounded to the nearest 1 square meter; the value of the area of the contour (part of the contour) in the land

survey plan is indicated in square meters, rounded to the nearest 0.01 square meter

The intersection areas are calculated in a separate column of the table using the expression: Area (obj, "sq m"). Figure 9 shows the intersection areas in square meters:

1. 77:01:0003027:112, 77:01:0003027:3665 – 259.543 m2;
2. 77:03:0003026:8, 77:01:0003027:57 – 13.788 m2;
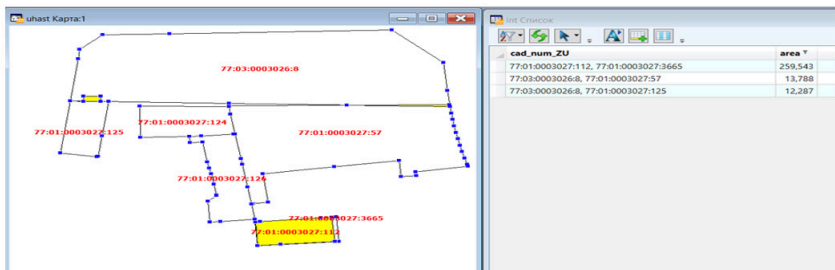3. 77:03:0003026:8, 77:01:0003027:125 – 12.287 m2.

Figure 9. Areas of intersection of plots

Such errors prevent setting on SCR. FSBI "FCC Rosreestr", upon finding such intersections, sends a notification about the impossibility of entering the territorial zone information to the applicant for registration. Violations are corrected by the organization that prepared the previously issued documentation with a registry error.

In order to correctly locate the characteristic points of the land parcels with violations, the nodes are aligned with the characteristic points of the adjacent parcels set on the SCR. To automate work in the MapInfo program there is a standard tool for checking the topology of polygons in MapInfo "Topology correction" and "Combining nodes and generalization of objects". The icon is shown in figure 10.
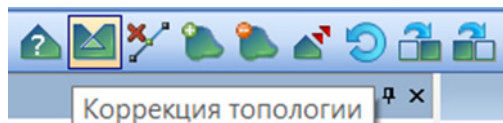

Figure 10. Standard tool for checking the topology of polygons in MapInfo "Topology correction"

The "Topology Correction" command allows you to remove any self-intersections of regions, as well as overlaps or voids. Topology correction is available when objects are selected and the table in which they are located

is editable. This tool removes overlaps when one object is completely inside another. The result does not contain any overlap.

Figure 11 shows the process of topology correction for the studied areas.

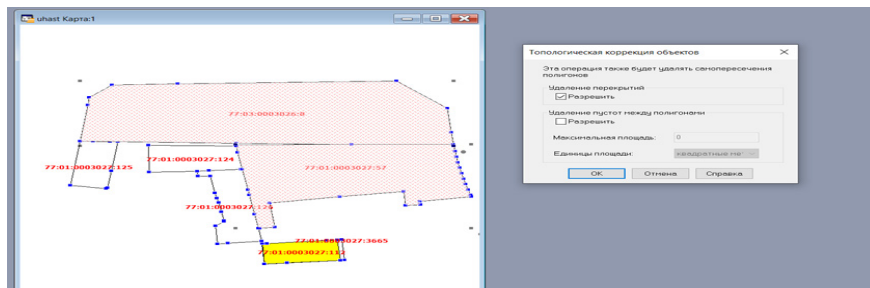**Figure 11. "Topology correction" command window**

The result of topology correction is that the two objects do not contain any overlap (fig. 12). In the process of applying this function, a node was formed outside the LP limit (fig. 13), which is not a correct display of the plot geometry. For this case, it is recommended to use the "Generalize nodes" command.
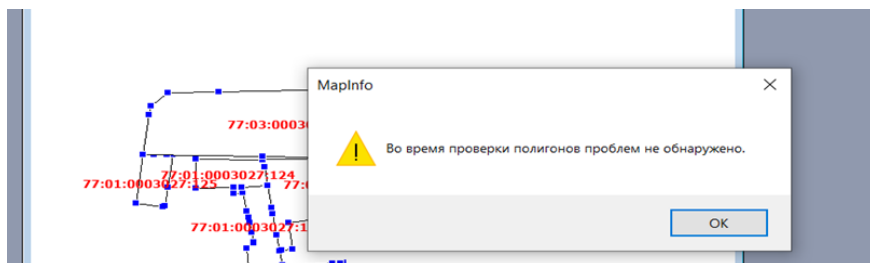

Figure 12. Topology check result window
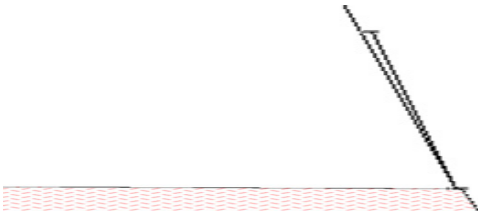
Figure 13. Node formed during editing by the command "Topology correction"

Combining and generalizing nodes allows you to remove redundant polygons in polygon features. The functions of this command will be discussed and presented in figure 14. The "Distance to end nodes" and "Distance to intermediate nodes" settings allow you to set the distance tolerance at which the nodes can be aligned. A thinning and generalizing operation based on a magnitude by joining three nodes into a triangle and then measuring the perpendicular distance between the second node and the line segment. "Removing redundant polygons" allows you to remove polygons with an area less than specified in the settings.

Figure 14. Setting the necessary settings to remove unnecessary nodes

We select the setting "Combining nodes of different objects". The node was removed during processing. The result is shown in figure 15.

Figure 15. Combined two contours through the "Combination and generalization" setting

The program supports the import and formation of documentation into an XML-file, approved by the Federal Registration Service.
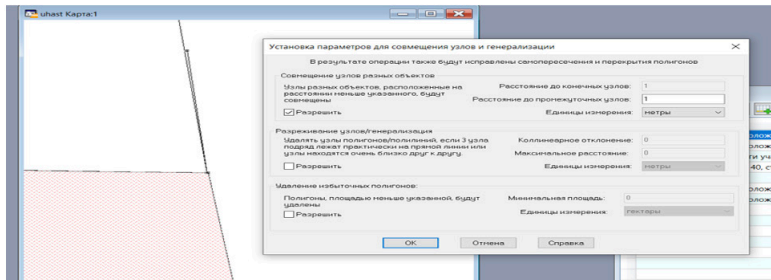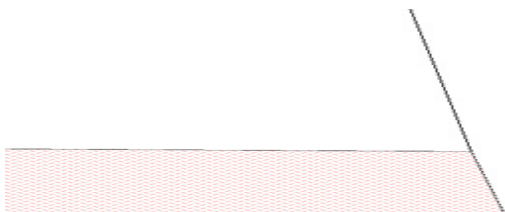
MapInfo also has the function of installing additional program extensions (utilities), which make it possible to: construct by coordinates and measurements, processing linear, angular marks, building a parallel and perpendicular, intersecting lines, solving geodetic problems and processing a tacheometer protocol.

The considered functions make it possible to check the topological correctness of points, lines and polygons, adjust them, calculate the area of objects and find intersections, update data about objects in the table. This toolkit is applicable in the manufacture of urban planning and cadastral documentation.

In order to register a zone with a unique number 77-01-02-000159, the following should be noted:

In order to put a territorial zone on the SCR and assign it a cadastral number, it is necessary to remove the intersection with the land plot with cadastral number 77:01:0003027:125 near the zone with the registration number 77.03.1.2856.

The plots recommended to be included in the zone 77-01-02-000159 have violations - intersections of land plots with cadastral numbers: 77:01:0003027:125, 77:03:0003026:8, 77:01:0003027:124, 77:01:0003027:57, 77:01:0003027:126, 77:01:0003027:112 and 77:01:0003027:3665. The formation of overlaps could have happened as a result of errors of the cadastral engineer in filling out the information of the land survey plan when placing land plots on the SCR.

It is recommended to carry out cadastral work to correct errors and consolidate the correct characteristic position of the boundaries. When preparing an up-to-date land-surveying plan, LP owners have the right to file a claim to change the boundaries of the land plot to exclude a register error.

The variant of the boundaries of the territorial zone was edited in the MapInfo software using the functionality that ensures the correct formation of the site topology, the site geometry is determined in accordance with the current legislation and is possible for setting on the SCR (figure 16).
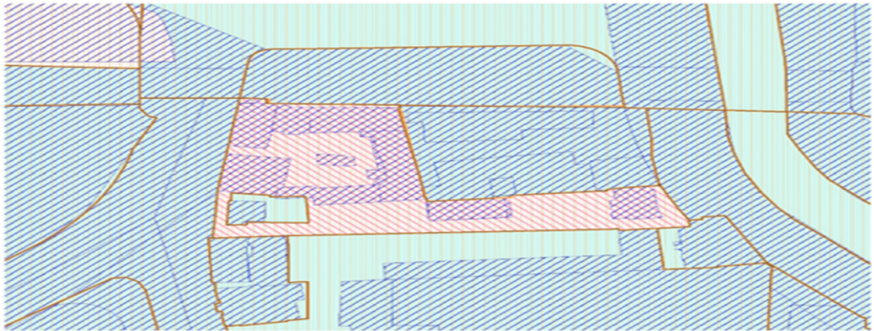
Figure 16. Borders of the territorial zone for state cadastral registration

In order to optimize work, eliminate errors in the manufacture of urban planning and cadastral documentation, the functionality of geographic information systems and geographic information portals is widely used.

Conclusions

The performed research allows highlighting the following important results:

1) provides an analysis of the legal framework;

2) the methodology for using GIS systems in practice in urban planning and cadastral activities has been improved;

3) the stages of checking for violations of semantic, graphic data have been implemented and a method for eliminating errors has been developed in order to register land plots with state cadastral registration;

4) proposals were developed to improve the application of GIS technologies in cadastral and urban planning activities.

The use of innovative technologies and solutions in the field of urban planning increases production efficiency, helps to save resources and reduce the cost of construction and maintenance of buildings.

Promising areas of application of geographic information systems in urban planning and cadastral activities are:

-Creation of information systems and geoportals – information resourc-

es that provide electronic interaction within the framework of a construction project.

-The use of smart contracts (contracts in electronic form) in construction and in real estate transactions, as an innovative contractual structure between participants using electronic technical means. "Smart" contracts allow automated execution of the type of obligations of the participants in the construction or transaction.

-The developed geoinformation programs allow the use of virtual and augmented reality in the design, modeling of construction objects. VR and AR systems provide access to detailed information about the parameters of the object, the quality of materials and structural elements of the information model.

-Application of innovative construction methods using three-dimensional printing of buildings and their individual elements. Digital modular construction and preparation of infrastructure for implementation according to a given three-dimensional model will significantly speed up and reduce the cost of building up territories.

Application of BIM technologies at all stages of the life cycle of construction objects. Designing an object as a whole based on BIM will cover all processes of the life cycle of objects, from the stages of urban planning and ending with the decommissioning of objects. A change in any technical parameter during construction entails, in the aggregate, a change in the characteristics, visualization and design of the entire project for an object.

Due to the impossibility of state registration of the territorial zone and the intersection of land plots, a correction of the topology of these objects was applied, and the appropriate software was selected, which made it possible to apply the improved methodology in practice.

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THE INEXHAUSTIBLE RESOURCES OF THE UNIVERSE

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Abstract. The problem of increasing the human factor and anthropogenic load on the earth's atmosphere is discussed. Forecasts of the consequences of changes in the composition of the planet's air atmosphere are studied. The calculation of the density of energy-mass of the Universe. This paper uses data from observational astronomy. It is assumed that the further study of the quantum vacuum should go only for the benefit of mankind.
Keywords: Universe, energy resources, air atmosphere, quantum vacuum, mass-energy density.

Cosmologists are interested in the fate of the evolving, expanding Universe. The Universe unites an infinite number of stars and planets: in the Milky Way Galaxy alone, which includes the Solar System, there are about 400 billion stars and 100 billion planets, and our planet is only one of them. The existence of human civilization on Earth is a unique phenomenon: the world science does not yet know the facts confirming the presence of intelligence anywhere else in space, except our planet. Nevertheless, according to scientists, there is a real threat not only to life on Earth, but even to the existence of the planet itself.

The works of historians, modern astronomical observations, geological data, information about the evolution of the Earth's biosphere testify to the catastrophic consequences of collisions of the planet with dangerous space objects (DSO) in the past. The solar system includes a huge number of the Earth and other planets. At the same time, the possibility of collisions, the consequences of which may have a global character, is not excluded. Proof of these facts are the craters that dot the surfaces of Mars, the Moon, Mercury, asteroids and comets, witnesses of the era of the birth of the planet. From time to time, these cosmic bodies move into orbits that intersect with the orbits of Mars, Mercury and other planets.

Evidence that the process continues in the modern era is the Tunguska catastrophe of 1908. A vivid demonstration of the scale of space strikes is a series of explosions in the atmosphere of Jupiter in 1994, caused by the fall of comet fragments on it. Collisions of such magnitude with the Earth would lead not only to the death of mankind, but also to the extinction of many species of living organisms. On Earth, with its powerful protective atmosphere and, consequently, erosion processes, craters eventually collapse and disappear.

The formation of the chemical composition of the Earth's atmosphere began about four billion years ago. Initially, it contained only light gases - helium and hydrogen. According to scientists, the initial prerequisites for the creation of a gas envelope around the Earth were volcanic eruptions, which together with lava emitted a huge amount of gases. In the future, gas exchange with water spaces, living organisms and products of their vital activity began. The composition of the air gradually changed and was recorded in its modern form several million years ago. The main components of the Earth's atmosphere are nitrogen (about 79% by volume) and oxygen (about 20% by volume). The remaining 1% is represented by the following gases: argon, neon, helium, methane, carbon dioxide, hydrogen, krypton, xenon, ozone, ammonia, sulfur dioxide, nitrogen dioxide. nitrous oxide and carbon monoxide. It should be noted that ozone, nitrogen and sulfur dioxides, carbon monoxide, nitrous oxide are present as impurities, and their content may vary. The concentration of carbon dioxide in our days, compared with the pre-industrial level (then, according to scientists, this value was 0.00028% by volume) has increased by 1.5 times. The record level of this value was recorded in 2015 and reached a value of 0.00041% by volume, according to data provided by the World Meteorological Association. This negative phenomenon was facilitated by the industrial impact of man, provoking global climate warming. In addition to gas components, the air contains water and solid particles are present: plant pollen, salt crystals, ground dust. The water content in the Earth's atmosphere depends on geographical latitude and ranges from 0.2% to 2.5% of the total volume of the air envelope. Water is an important heat accumulator and is contained mainly in the lower layers of the atmosphere. With increasing altitude, its concentration steadily decreases. Up to a height of 100-120 km due to complete mixing of the air, the composition of the atmosphere is homogeneous. Beyond these values, the ratio between nitrogen and oxygen begins to change. For example, at an altitude of 200-800 km, nitrogen content is 10-100 times more prevalent than oxygen. The upper atmospheric layers account for a small part of its mass, but they significantly determine

the quality of life on the surface of our planet. At an altitude of 500-1000 km, helium becomes the main constituent component. The helium corona of the Earth extends to about 1600 km, above 2000-3000 km hydrogen predominates. These light layers of the atmosphere protect our "Cosmic Home" from the flow of rays and protects from a series of high-energy particles.

The energy of space excites the minds of scientists, many issues remain unresolved. The key role in the fate of the Universe (closed, open, stationary) is played by the density of energy-mass (equivalent to Einstein $E - m \cdot c^2$, where E is energy, m is mass, c the speed of light).

It is established that the energy-mass density of the Universe is close to critical, the boundary between closed, i.e. the transition from expansion to contraction, and open, i.e. infinitely expanding, is elusive.

Deviations of the energy-mass density of the universe from the critical one are estimated at 10^{-60} (P.C.W. Daviesh). A high degree of proximity or even equality is confirmed by measurements with high-precision relic radiation devices. The temperature of the relic radiation turned out to be equal to $2{,}725\pm0{,}001$ K. Anisotropy of radiation of the order of 10^{-4}-10^{-5} K was also detected. The issue of energy-mass density is complicated by the fact that the total mass of the observed matter is less than 1% of the critical mass. Observations of the rotation of galaxies and clusters of galaxies allow this difference to be brought to 10-25%. This difference was called dark matter (it does not emit and does not absorb, i.e. it is not observed). The remaining 75-90% were given the name of dark energy.

At the same time, it is obvious that the observed matter originated from the space-time field. Although such a field name is not the most successful, a good name for any object is of great importance for assimilation, if not the essence, then popularization. We can suggest such names as quantum vacuum, scalar field, etc.

The opinion of S. Hawking that the total energy of the Universe is zero is unconvincing. It is known that vacuum participates in long-range interactions – electromagnetic and gravitational. There are concepts of negative energy (since there is a positive one in the form of galaxies, stars, planets, etc.), mass, Kelvin temperature. This, of course, is not proof, but a reason for doubt, although the authority of S. Hawking is too great to deny his opinion.

It is logical to assume that before the emergence, i.e. before the "Big Bang", the energy field (quantum vacuum, scalar field) existed. It could be called an "empty" space or an "empty" universe. According to this hypothesis, it is possible to calculate the energy-mass density based on the fact

that it is almost close or even equal to the critical one. Given that the field is uniform in space, according to the K. Schwarzschild formula, we have: $R = \frac{2 \cdot G \cdot M}{c^2}$, where R is the gravitational radius of the sphere, m; c is the speed of light equal to $3 \cdot 10^8$ m/s; M_V is the mass, kg; G is the gravitational constant, which is equal to $6.67 \cdot 10^{-11}$ m³/(kg·s²). Energy-mass volume of one cubic meter (radius $R = 0,62\ m$) is equal to:

$$M_V = \frac{R \cdot c^2}{2G} = \frac{0,62 \cdot (3 \cdot 10^8)^2}{2 \cdot 6,67 \cdot 10^{-11}} = 4,18 \cdot 10^{26}\ \text{kg}$$

Energy, in turn:

$$E = M_V \cdot c^2 = 4,18 \cdot 10^{26} \cdot (3 \cdot 10^8)^2 = 3,762 \cdot 10^{43}\ {}^{j}\!/_{\text{m}^3}.$$

By the way, the fact of the constancy of the speed of light in our Universe, measured with great accuracy, is also a property of the field of this Universe.

The scenario of the origin and development of the Universe with the formation of material objects (photons, baryons, stars, galaxies, etc.) under the assumption, or even according to the founders of modern cosmology, such as Einstein, Friedman, Hawking, etc., leads to the idea of a spherical shape, i.e. the universe-space before the appearance of the observed objects also had a spherical shape.

Another logical hypothesis is the rotation of the universe-space. Rotation is characteristic of all known objects of matter: nuclei (hadron), planets, stars, galaxies. Rotation creates a centrifugal force, i.e. the force of repulsion, inflating. Einstein introduced such a force (the force of repulsion, antigravity) into his general theory of relativity (GRT) in order to create a model of a stationary Universe. However, after discovering the fact of inflating, he abandoned this idea, calling it his mistake.

The study of the energy field (quantum field, gravitational field) has developed in several directions, such as quantum gravity, quantum chromodynamics (QCD), superstring theory, supergravity. Certain successes have been achieved in electrodynamics, electroweak interaction. QCD does not include gravity, the electro-strong interaction (the structure of nuclei, hadrons), rests on energies of the order of 10^{15}-10^{16} GeV. The inclusion of gravity in the theory (superunion theory) will lead to even greater, at least by several orders of magnitude, energies, for example, up to 10^{28} GeV.

Experimental studies of such high energies require the creation of com-

plex and expensive instruments: ground-based and orbital telescopes, synchrophasotrons, a large collider. A powerful means of theoretical research is mathematics, armed with supercomputers. The achievements of quantum metrology are impressive: time up to 10^{-11} seconds, pico-voltmetry up to 10^{-14} V, picoamperometry up to 10^{-15} A, lengths up to 10^{-11} m. The rapid development of science allows us to hope that it is possible, if not completely solved, then much closer to solving the laws of the origin, evolution and fate of the Universe.

The traditional classification of energy resources from low-potential, such as wind energy, solar energy, biomass energy to high-potential energy carriers (oil, natural gas, solid fuel) does not provide for energy of the same scale as the Universe. As a result, there are problems with the possibility of storing, measuring, and moving this energy resource.

An alarming question arises: any achievement of science and technology does not always go to the creation of goods, often to the creation of means of destruction. Nuclear energy is not only power plants, but also bombs. Thermonuclear energy is currently used only for bombs, its use in peaceful affairs has not been achieved.

The energy of the quantum vacuum field exceeds the known energy sources by many orders of magnitude. Such energy levels are dangerous not only to the planet, the solar system, but also unfavorable for the development of living organisms, intelligence and intelligence. The energy resources of the Universe, with universal efforts, can become an alternative to all other energy sources. The new geopolitical stage will lead to the unification and integration of all countries of the planet. Let's preserve our "Spaceship-Earth" and the radiance of its helium corona for future generations.

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DYNAMICS OF THE BIRTH RATE OF THE POPULATION OF PRIMORSKY KRAI:
FACTOR ANALYSIS

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Annotation. The current birth rate in the Primorsky Territory is considered. The analysis is carried out by demographic factors affecting the total number of births per woman of reproductive age. Over a long period (1959-2019), the number of women - 15-45 years old, in the age structure increased by 50 thousand people, and the number of children born per woman, the total fertility rate, decreased by 2.29 times. The birth rate is influenced by a significant decrease in the standard of living of the population, contributing to the outflow of young people from the region.
Keywords: Primorsky Krai, demography, fertility factor, total fertility rate.

Introduction. The strategy of demographic development of the macroregion and its individual subjects up to the beginning of market transformations was determined by the standard concept of economic development, when the goals of economic development determined the relationship between the material factors of production, and after that the need for labor resources was formed. The demographic development of the Far East was influenced to the maximum extent by the state and regional policy on the purposeful formation of the population. The transformation of the economy has led to negative regional imbalances in the conditions and quality of life, destroyed the unity of the economic space of the region. The current

trends in natural and migration movement have affected the conditions of territorial development. As a result, differences in the participation of the population in spatial mobility affect demographic indicators, affecting not only the decline in numbers, but also the transformation of the gender and age structure in territories with migration outflow.

On the one hand, a certain part of the population, due to the liquidation of enterprises, the reduction in the number of employees at enterprises, is unclaimed. On the other hand, the emphasized influence of a low level of social well-being, pushing for departure, is not decisive, since more mass migration comes from urban districts with a sufficiently high level of infrastructure provision, with a high level of education of the population. The main message of all those who leave is low wages, and then insufficient social education is already mentioned. In European, especially metropolitan cities, wages are significantly higher, and, it should be emphasized, without a district coefficient. In the last three decades, the country has not carried out a radical restructuring of the organization and methods of management, nor has a technological basis been created in accordance with the new round of technology development. The economy has not received a new quality of development, and the state as a public institution has not understood this need. Social contradictions have been created that are unable to resolve the transition from an authoritarian to a constitutional state, when all social strata reach the necessary agreement of the forces of society, even those with opposing interests. The current situation is not only a local problem. As the authors rightly note [4], regional imbalances limit social progress, lead to the emergence of the threat of separatism, to complicate the problem of interregional migration, interregional exchange.

Factor analysis of fertility

The possibilities of the future development of the territory are connected with the replenishment of the population at the expense of young people, the level of natural reproduction. At the same time, the value of the total fertility rate largely depends on the gender and age structure of the population. The higher the proportion of women of childbearing age in the entire population, the greater the overall fertility rate, all other things being equal. The outflow of population at the end of the XX century and the 2000s, led to a significant reduction in the birth rate in the region. The slowed down migration outflow in the following 2010s contributed to an increase in the birth rate, an increase in the number of young people. Thus, the growth in the number of women aged 15-49 allowed to compensate for the low birth rate to some extent [1]. After the decline in the birth rate in the 1990s, there was a noticeable increase in the number of children born in the noughties. However, this is not enough for positive dynamics.

When studying the dynamics of the total fertility rate, it should be established: to what extent its change was due to an increase or decrease in the actual birth rate, and to what extent - a change in the proportion of women of reproductive age in the total population. To characterize the birth rate in certain population groups, private indicators are used. Their distinctive feature is that they are calculated not for the entire population, but for individual constituent groups, for example, the intensity of childbearing varies greatly by age groups within the reproductive contingent of women. It is possible to understand the processes taking place, assess the dynamics, possible consequences, and show the dependence in dynamics with the help of several factors affecting fertility [1, 2].

The total fertility rate can be represented as a function of three variables: the special fertility rate, the proportion of birth contingents, the proportion of women in the population. What is the impact of each of the demographic factors on fertility is shown by the example of Primorsky Krai, in Table.1.

Table 1.
Initial data for the decomposition of the total fertility rate by factors

Factors	Years			Absolute increase (+), decrease(-)		
	1959	1995	2019	1995/ 1959	2019/ 1995	2019/ 1959
The number of women, to-tal, thousand people,	717,5	1147,5	992,520	+429,9	-154,98	+275
including those aged 15-49 years, thousand people.	397,14	601,0	445,064	+203,86	-155,9	+47,9
Special fertility rate, per 1000 people.	83,6	38,0	44,9	-45,6	+6,9	-38,7
The proportion of women in the population, %,	52,3	50, 5	52,2	-1,8	-5,17	-0,1
including those aged 15-49 years, %	28,8	26,5	23,4	-2,4	-3,1	-4,6
Proportion of women aged 15-49 in the female popula-tion, %	55,3	52,4	44,8	-2,9	-7,6	-10,5
Total fertility rate, per 1000 people.,	24,1	9,4	10,5	-14,7	+1,1	- 2,29 times

Source: data from the State Statistics Committee and the Primorsky Krai Archive.

Note. Calculated by the author.

From the table.1 it can be seen that by 1995 (in comparison with 1959) the number of women increased by 430 thousand people, of them aged 15-49 years - by 204 thousand people.. But the proportion of women in the population has changed slightly: there are 2% fewer women in the total population and 2.5% fewer of them in young age groups. At the same time, the total fertility rate decreased by 14.7 points.

At the birth of children, the largest number of births falls on the age of women in the range of 25-39 years. In total, for example, 19995 children were born in 2018, of which 10902 were married and out of wedlock (including at the request of both parents) 3493 children. The total fertility rate in Primorsky Krai by 2018 was only -1.577, including for the urban population - 1,460, and rural - 2.12 children per 1 woman of fertile age.

The dynamics of the decline in the number of births is tracked by the example of changes in the total fertility rate, Table 2.

Table 2.
Total fertility rate (number of births per 1000 women aged 15-49 years) across the Primorsky Territory

	Russian Federation	Russian Far East	Primorsky Krai
1959	2,620		2,607
1970	1,972		1,885
1979	1,901		2,067
1989	1,757		1,990
2005	1.294	1,424	1,314
2010	1.561	1,625	1,492
2013	1.707	1,814	1,685
2015	1.777	1,893	1,761
2017	1.621	1,725	1,597
2018	1.579	1.741	1.577
2019	1.504	1.671	1.488

Sources: statistical data

The influence of social factors affects not only the final number of children in the family, but also the timing of their appearance. With the wide-

spread occurrence of delayed births, it is possible to imagine the dynamics of births in the near future from two patterns of behavior of the population of reproductive ages. One of them is delayed births for those who got married in the 1990s, the second is for those who got married in the zero and tenth years of the XXI century. [3].

Married couples who married in the 1990s determined the birth rates of the late twentieth century and the first decade of the 21st century. More numerous generations born in the late 1980s entered the reproductive age in the 2000s and 2010s, and in this regard, there was a projected increase in the birth rate, with stabilization at the level of 18-20 thousand annual births, which corresponds to 8.0 - 10.0 per 1000 people. In the future, since 2015, there has been a decline in the birth rate, since a few generations born in the 1990s entered the reproductive age.

What would be the number of births with the same (standard) structure of women of childbearing age and unchanged age-specific fertility rates? The main losses in the birth rate can be attributed to the consequences of changing the calendar of births over time during the childbearing period. In the conditions of conscious regulation of childbearing by spouses, the interval between the birth of the first and second child increased due to changes in social norms during the "establishment" of children in the family and lifestyle changes. The majority of existing families that are of reproductive age, indefinitely refuse to have second and subsequent children in them, and in newly formed families, the appearance of the firstborn is even postponed.

The situation in the birth rate at the end of the twentieth and the beginning of the twenty-first centuries can hardly be called optimal. However, it would be erroneous to assume that its regional level, characteristic of the 1950s, would ideally meet the requirements of sustainable demographic development in the new century. The indicators of the total fertility rate were insufficient for expanded production even in 1959, despite the fact that the total fertility rate was equal to 24.1 per 1000 population. In the period from 1980 to 1995 the number of births decreased from 2.2 to 1.3 children per woman, which clearly indicates the narrowed nature of reproduction. Thus, we can make sure that on the territory of the krai, as well as on the entire territory of the Far East, there has been a simple generation substitution for a long enough period of time.

The dynamics of the total fertility coefficients clearly shows that the renewal of generations is going towards a narrowing of the number of subsequent generations relative to the previous ones. The picture in the reproduction of the population is even more aggravated if we analyze the

renewal of the female population (net reproduction rate) objectively reflects the situation. The named coefficient was already below one in 1989, a thousand women had 800-900 girls, by 1994 this number had decreased to 560-700 [2,3]. Net reproduction coefficient showing the replacement of female generations in 1996 it was equal to 0.557, i.e. only 557 girls were born to 1000 women, which is only 30% of the biologically possible birth rate. It is not entirely true to explain such a situation only by the deterioration of the standard of living of the population in the 1990s.

The main reason for this situation is associated with a decrease of almost 3 times the number of births per woman of childbearing age, although the proportion of women of reproductive age in the age structure of the population has changed slightly. And if even in 1959 the number of children born did not reach the level of simple replacement of generations, the special fertility rate was equal to 1.81 with a total fertility rate of 24.1 per 1000 population, then for the late twentieth and early twenty-first centuries the situation has become critical. Every next generation of women is less than the previous one by a third. The prevailing trends and the rate of decline in the intensity of the birth rate have brought the demographic and social gap to which the region has been heading in recent decades closer.

Conclusion

The calculations carried out show that the Primorsky Territory, as in the whole Far East, in the last decade, it is not necessary to hope that more numerous subsequent generations will replace the outgoing generations. It would be fair to assume that the annual decline in the number of births is a natural phenomenon in itself. But the whole question is how fast this process is going, what are the reasons that caused it, and whether there is a birth rate beyond which its decline becomes socially and economically dangerous. The observed decline in the birth rate in recent years can be regarded as having reached a critical state, and further reduction in it may be dangerous from a political point of view.

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COMPARATIVE ANALYSIS OF THE REPRODUCTIVE CAPACITY OF MINKS OF DIFFERENT BREEDS

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Abstract. The article presents the results of whelping of females of the Standard (STK), Scan Black and Silver-blue breeds for 2019-2020, it was revealed that the STK breed of minks is distinguished by a higher reproductive ability due to the absence of missed females in the sample and a low percentage of unsuccessfully given birth and died females.

Keywords: mink, fertility, whelping, female, silver blue, scan black, standard breed

Introduction

Under the conditions of cage breeding, fur-bearing animals retained the seasonality of reproduction. They bring offspring once a year - in the spring.

The leading object of cellular fur farming is the mink.

This is due to the fact that mink skins have a wide range of color types, which is actively used in the fur industry for the manufacture of various products. [1-3]

In a mink belonging to the weasel family, the rut is short, takes place in the first weeks of March, pregnancy lasts up to 80 days due to the latency period. The average fertility of the mink is 6-7.5 puppies. [3-6]

The main goal of breeding in fur farming is to increase the quality and volume of products by improving the breeding qualities of animals.

There are many breeds and breed types of minks, which have their own characteristics and economically useful characteristics. So animals of the

breeds "Silver-blue" and "Scan Black" are distinguished by a rare natural color of the skin, as well as a high density of the down and a special shine, elasticity and uniformity of fur.

Three breeds of minks are kept and successfully bred at the "Breeding Animal Farm "Saltykovsky" JSC in Balashikha, Moscow Oblast: Standard (STK), "Silver-Blue" and "Scan Black". [1, 2, 3]

The farm is a member of the "Agro-300" club, this club unites 300 of the best agricultural enterprises of the Russian Federation. Throughout its history, Saltykovskaya fur has been highly appreciated at competitions and exhibitions held at the All-Russian Exhibition Center (VDNKh), repeatedly winning high prizes for quality and large size.

Currently, the farm annually grows about 60-80 thousand minks for sale.

The color of the mink depends on the presence of black or yellow pigment in the hair. Different amounts of black pigment give a color from black to light gray, yellow - from dark brown to cream.

Approximately half of all mink production is made up of standard mink skins, which are considered the original wild form on the basis that minks of this color are widespread in nature. Most standard dark brown minks have white spots of various sizes on the chin, neck and chest, and some animals have white stripes on the abdomen and white spots on the legs. Their eyes, nose and nails are dark brown. The opaque hair has a more uniform and dark color compared to underfur. The underpuff is mostly dark brown or gray-brown in color with pronounced brown tops. Sometimes the underfur is brown or gray and very rarely black and pure gray with a bluish tinge. In many animals, intermediate and downy hairs are very weakly pigmented. [1, 3]

In the breed "Silver - blue", the general color of the pubescence is uniform, bluish - gray. The tail and legs are darker in color. The eyes, like those of a standard mink, are black. The awn is pearl gray or silvery blue, bluish gray or sky blue. Silver-gray minks are large, undemanding to care for. They are distinguished by good reproducibility and viability.

"Scan Black" — Scandinavian natural black mink, has an equalized guard hair of medium length, which covers a thick underfur, is distinguished by a special shine. Sometimes this mink is called "black diamond" because it shimmers with all the colors of the rainbow. Within the group, there can be found both taller fur (Finnish selection of Saga Furs) and low fur (Danish selection, Kopenhagen Fur marking, where the quality of Purple, Platinum, Burgundy, Ivory is distinguished).

Purpose and objectives of research

The aim of the research was to study the reproductive abilities of mink black, standard (STK) and silver-blue breeds.

To achieve the goal, the following tasks were set:

1. To study the method of keeping minks on the example of "Breeding Animal Farm "Saltykovsky" JSC in Balashikha, Moscow Oblast.

2. To study the dynamics of the reproductive abilities of females of the parental herd of minks during a given period of time (2019 - 2020).

Material and research methods

The research was carried out in the conditions of "Breeding Animal Farm "Saltykovsky" JSC, Balashikha, Moscow Oblast.

In the fur farm, the main herd and young minks are kept in individual cages, which are placed in sheds. Males are often housed in separate cages outside. The floor of the service aisle is asphalted or concreted. The width of the shed is about 4 m, the length is at least 60 m. In multi-row sheds, the cells are arranged in 4, 6, 8 and 10 rows. More than 3 thousand cells can be placed in one six-row shad. [5]

Figure 1. Universal shed for keeping fur animals

Feeding rates for minks have been developed on the basis of numerous scientific, economic and balance experiments at SRIFRB.

Table 1.
Approximate structure of diets for minks,% per 100 kcal of metabolizable energy

Feeds	Period				
	Rest	Preparing for breeding	Pregnancy of females	Lactation of females	After separating the young
Meat and offal	40 – 45	45 – 62	40 – 45	40 – 45	40 – 50
Fish and fish waste	25 - 35	15 - 20	20 - 30	20 - 30	30 - 32
Milk and dairy products	-	-	5	10	5
Cereals	13 – 28	10 - 23	11 - 21	10 - 20	10 - 22
Rich	2	2	2	3	2
Yeast	3	3	4	-	3
Fish fat	2	2	3	3	3

"Breeding Animal Farm" Saltykovsky "has mastered modern technologies for breeding fur-bearing animals. In selection and breeding work, the computer program "Breeding selection" is actively used on all types of animals, which makes it possible to effectively control the selection process on a large number of several species and colors of animals.

The analysis of the data of the primary zootechnical documentation for 2019 - 2020 was carried out for three breeds of minks bred in the fur farm: scan black, silver-blue and standard (STK) breeds. On the basis of the data obtained, the reproductive abilities of the studied groups of minks were studied.

For the analysis, 40 zootechnical cards of females of three breeds were selected, 20 each for 2019 and 2020, respectively. The studies were carried out on known healthy animals. Groups of experimental minks were assembled according to the principle of analogs by origin, sex, age, live weight, physiological state, color and quality of the hair coat.

Based on the results of the analysis, the indicators of the reproduction of females were recorded: the number of covered, missed, safely whelping females, their fertility, the number of living and dead puppies, the release of young animals to the main and safely whelping female by the time of registration.

Research results

The reproductive ability of fur-bearing animals is assessed by the results of rutting and whelping, and in adult animals, data for the period of their use are taken into account. Table 2 shows the results of whelping the breeds of standard (STK), scan black and silver-blue in the conditions of "Breeding Animal Farm "Saltykovsky" JSC Balashikha, Moscow Oblast in 2019-2020.

Table 2.
The results of pupping females in 2019-2020 (n=120)

Indicator	Breed		
	STK	Scan Black	Silver-blue
Females covered, heads	40	40	40
Females missed,%	-	2.5	5
Females NBR,%	5	7.5	5
Females died before whelping,%	2.5	2.5	5
Received puppies, heads total	177	154	140
per a covered female	4.4 ± 0.35	3.9 ± 0.37	3.5 ± 0.50
per a safely whelped female	4.8 ± 0.29	4.4 ± 0.41	4.1 ± 0.29

After analyzing the results of whelping for females of the STK, Scan Black and Silver-Blue breeds for 2019-2020, it should be noted that the STK mink breed is distinguished by a higher reproductive ability due to the absence of missed females in the sample and a low percentage of females that gave birth in an unsuccessful manner and died.

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CROCOSMIA×CROCOSMIIFLORA (LEMOINE) N.E. BR – JAPANESE GLADIOLUS

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Abstract. The article describes the characteristics of the Iridaceae Juss family, studied some varieties of *Crocosmia×crocosmiiflora* (Lemoine) N.E. Br.

Family Iridaceae Juss. - a fairly large family, which includes about 1800 species belonging to 75 - 80 genera. The range of this family covers almost the entire land area of the globe. The representatives of the studied family are perennial grasses, often ephemeroids with fleshy rhizomes, tubers and bulbs.

The aim is to analyze some members of the Iridaceae Juss family. and to give a comparative assessment of the biological characteristics of varieties *Crocosmia×crocosmiiflora* (Lemoine) N.E. Br

Crocosmia×crocosmiiflora (Lemoine) N.E. Br (Lemoine) N.E. Br is closely related to popular flower crops such as iris, gladiolus, crocus, ferraria and freesia. Crocosmia is most often used to decorate open flower beds, growing together with such plants as canna, salvia, daylily, rudbeckia and echinacea. This flower is also suitable for cutting, so its inflorescences can stand in water for up to a half moon.

Keywords: Iridaceae Juss., *Crocosmia×crocosmiiflora* (Lemoine) N.E. Br, corms, montebrecia, interspecific hybrid, tritonia, Japanese gladiolus.

Family Iridaceae Juss. - a fairly large family, which includes about 1800 species belonging to 75 - 80 genera. The range of this family covers almost the entire land of the globe, excluding most of the Arctic, the extreme north of the taiga zone of Eurasia, as well as some deserts and areas of the lowland tropics with rain forests [4]. Almost all iris are perennial grasses, often ephemeroids with fleshy rhizomes, tubers and bulbs. Only representatives

of 3 South African genera of the tribe *Nivenieae*: *Nivenia N. R. Br.*, witsenia and clattia are peculiar evergreen half-shrubs with branched woody stems up to 0.5 m in height, which have the ability to secondary growth [1].

In its large northern part with a moderately warm climate, only a few genera of this family are represented, of which the species-rich genera of iris and sisyurinchium, or *Sisyrinchium*, penetrate farthest to the north - to the southern regions of the Arctic. Two areas of the greatest diversity of irises stand out sharply: the South African region, where 45 genera and about 900 species are found, and the Central South American region, with a smaller number of genera and species. The representatives of this family are very poor in Southeast and South Asia. In Australia, Tasmania and New Zealand, irises are represented by 7 genera, of which 3 are endemic - *Isophisis*, *Diplarrhena* and *Patersonia* - are very original in morphology. There are especially many endemics - 28 genera and about 450 species - in South Africa (Cape Floristic Kingdom), moreover, the range of many of them (for example, the peculiar semi-shrubs *Witsenia* and *Klattia* are limited by a small area in the southwestern part of the Cape Land. The predominant distribution of irises in the southern hemisphere allows us to associate the origin of this family with parts of ancient Gondwana, as evidenced, in particular, by the existence of gaps in the ranges of some genera, such as *Dietes*, between South Africa, Australia and New Zealand. American genera are much more isolated from African and Australian, however, one species of the predominantly American genus Sisyrinchium - *Sisyrinchium pulchellum* - is widespread in Australia, New Zealand and New Guinea [4].

Iris leaves without petioles, usually arranged in two rows and divided into a sheath-like base and a plate with parallel venation. The most common form of leaf blades is xiphoid, especially characteristic of rhizomatous genera, for example, iris or sisyurinchia. In crocuses, such leaves are very narrow, with the lateral sides turned down [6].

The goal is to analyze some representatives of the Iridaceae Juss family and to give a comparative assessment of the biological characteristics of varieties *Crocosmia×crocosmiiflora* (Lemoine) N.E. Br

Tasks

1. Explore the Iridaceae Juss family.

2. Give a comparative characteristic of varieties *Crocosmia×crocosmiiflora* (Lemoine) N.E. Br

Corms, from the Iridaceae family, have begun to be dealt with in the Far Eastern State Agrarian University since 2017. Various species and varieties of this family are being studied (*Iris domestica* L., *Iris laevigata* Iris laevigata, *Gladiolus hybrid Hort*., *Crocosmia×crocosmiiflora* (Lemoine)

N.E. Br), but the demand for bulbous crops is not weakening, new interesting specimens appear.

Crocosmia or montebrecia (tritonia) (*Crocosmia*) is a genus of about 7 species of corms from the meadows of South Africa. The name "crocosmia" comes from the Greek words crocos - crocus and osme - smell, aroma, because the smell of its dried flowers resembles crocus. The term "montbretia" is associated with the name of the French botanist De Montbret. The name "tritonia" is associated with the Greek word triton - weather vane and is given because of the spreading shape of the inflorescence. Among flower growers crocosmia is known as "Japanese gladiolus", because its flowers are similar in shape to miniature gladiolus flowers [7]. This name conveys the exact image of the mysterious East: like a real Japanese woman, crocosmia slightly bows its head, obeying the will of the "owner", but with its timidity evokes admiration and respect, attracting the eye with its perfect beauty [6].

Crocosmia×crocosmiiflora (Lemoine) N.E. Br is an interspecific hybrid of *Crocosmia aurea* (Pappe ex Hook.) Planch. × *Crocosmia pottsii* (Baker) N.E.Br. *Crocosmia*. In culture since the middle of the 19th century [11, 3].

Crocosmia×crocosmiiflora, plants up to 100 cm tall. The stem is straight, thin, branched. Leaves are light green, broadly linear or narrowly obvious, up to 2.5 cm wide and 40-60 cm long, erect, in dense bunches. The flowers are not large - 3-5 cm in diameter, funnel-shaped, orange-red or yellow, collected in a small apical paniculate inflorescence. Blossoms in July-August, up to 10 flowers open at the same time. 3-4 peduncles grow from 1 corm. *C.crocosmiiflora* is not a whimsical plant that requires minimal maintenance. Prefers conditions of moderate moisture, moderately fertile, well-drained soil in full sun to partial shade. It can grow on any moisture-permeable soils, with the exception of very poor ones. Crocosmia forms many babies that bloom the next year. Requires digging for the winter in regions with cold winters [2, 10].

Economic and biological characteristics are due to: seed or vegetative reproductive ability; resistance of plants to damage by pests and diseases, to unfavorable weather and climate conditions; timing of flowering, fruiting. However, these signs can change depending on weather conditions in individual years of plant age.

In Australia, *Crocosmia×crocosmiiflora* (Lemoine) N.E. Br has been recorded blooming mainly in summer and autumn, but also in spring in warmer climates (Weeds Australia, 2016). In New Zealand, it blooms from December to April. In Central America, it was collected with flowers from April to August [10]. In tropical regions, this species grows continuously

throughout the year, but in subtropical regions, it dies off every year [9].

The climate of the Amur Region is sharply continental in terms of temperature and monsoon in terms of its formation. The main factors determining the climate are its geographical position on the Eurasian continent, the orography of the territory, the monsoon nature of atmospheric circulation and cyclonic activity. The climate of the region is formed under the influence of both oceanic and continental air masses, is distinguished by sharply expressed features of continentality and at the same time has a monsoon character [5].

Conditions in Blagoveshchensk are suitable for growing *Crocosmia×crocosmiiflora* (Lemoine) N.E. Br), due to favorable climatic conditions, the culture manages to go through all phenological phases and retains its decorative effect throughout the growing season. In this connection, it was decided to replenish the collection with 4 varieties:

George Davidson cultivar. The variety has delicate and showy medium-sized flowers with gracefully open amber-yellow petals, rounded at the ends. The leaves of the representatives of this variety are green, but darker than those of others. Blooms in July, flowering continues until mid-August [8].

The Lucifer cultivar is bred in the middle of the last century by crossing Crocosmia paniculata and Crocosmia Masonorum. It is quite widespread. Lucifer stands out for its striking, brightly colored red flowers.

Long, xiphoid leaves grow up to 120 cm in height. The variety is frost-resistant and unpretentious, with traits inherited from the original type of paniculata [8].

Mistral is a beautiful decorative variety. It has dense brick-colored inflorescences. The life cycle of the Japanese gladiolus can be noted in 2 stages. The first stage starts at the end of April. It consists in the active growth of green mass, ends with the formation of testes. The second stage begins after flowering. For the growth of corms, the plant needs rest. At this time, the flower needs cooling and a short warming up. Each year, an adult corm brings about 5-6 babies. They will bloom next year. The first is the growing season of the aboveground part. The second stage is the growth of corms [8].

Emily McKenzie is a late flowering, medium-sized 60 cm cultivar with large, bright and variegated flowers with brownish and orange spots at the base. Prefers to grow in light partial shade. The height of the compact bush reaches 0.6 meters. The upright arrows have a large number of brownish-orange flowers, which have a speck of bright color in the middle. Excellent frost resistance. Unpretentiousness. Minimum care. Active growth. The planted "babies" bloom the next year [8].

Conclusion

Crocosmia×crocosmiiflora (Lemoine) N.E. Br is closely related to popular flower crops such as iris, gladiolus, crocus, ferraria and freesia. Crocosmia is most often used to decorate open flower beds, growing together with such plants as: canna, salvia, daylily, rudbeckia and echinacea. This flower is also suitable for cutting, so its inflorescences can stand in water for up to a half moon.

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CULTIVATION OF SPRING RAPESEED AND SPRING WHEAT IN THE NORTH KAZAKHSTAN REGION

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Abstract. The technology of cultivation of agricultural crops is based on the use of scientific achievements and advanced experience. To obtain high-quality, and most importantly, stable yields, it is necessary to study the elements of technology for the cultivation of agricultural crops. The article presents the results of research on the yield of spring wheat cultivated by the first crop by types of fallow and the yield of varieties and hybrids of spring rapeseed, cultivated with pure fallow at different seeding rates for 2020-2021. In the Republic of Kazakhstan, these two agricultural crops occupy a special place and are the most cultivated, no other agricultural crop is as widespread in the world as wheat. Over the past decades, many positions in the cultivation of spring rapeseed have changed, and the varietal composition is no exception, since in a changing climate it is necessary to select varieties adapted to the conditions of external factors, and fallows, as a predecessor, contribute to a greater grain harvest of spring wheat, in comparison with other predecessors.

Keywords. Spring rapeseed, spring wheat, cultivation, productivity, varieties, hybrids, fallows.

Introduction

The study of the elements of cultivation technology is the foundation for obtaining high and high-quality agricultural yields, and the improvement of technology will increase the efficiency of production itself. Spring wheat has been a leader in sown areas for a long time, and interest in spring rapeseed has arisen relatively recently, since thanks to the achievements

of breeders, it became possible to use it in the food industry, which increased the demand for this crop. Any technology for the cultivation of an agricultural crop begins with the selection of a predecessor, the selection of varieties and hybrids that meet all the requirements.

Objective of the research: to study the effect of the types of fallow on the yield of spring wheat and the effect of the seeding rate on the yield of varieties and hybrids of spring rapeseed.

Research objective: to analyze the influence of the types of fallow on the yield of spring wheat and the effect of the seeding rate on the yield of varieties and hybrids of spring rapeseed.

Fallows - as a precursor, contribute to a greater grain harvest of spring wheat, in comparison with other predecessors [3, p. 26-33].

Soil cultivation in fallows is the most important agronomic measure [1, p. 16-21]. The best results are achieved without giving up the basic tillage [4, p. 21-25.9, p. 3-8]. The main criterion for evaluating the used processing technique or their systems is the yield value. The yield of wheat placed first after a busy fallow is higher, while its remoteness reduces this indicator [2, p. 71-74]. One of the main ways to increase the productivity of agricultural crops is the observance of crop rotation [5, p. 139-142, 10, p. 190-195], carrying out the main tillage, the predecessor [8, p. 156-161].

Field studies in the cultivation of spring wheat by fallows species were carried out in the production conditions of the "Kursabaev" farm, the village of Muromskoye, Zhambyl district of the North Kazakhstan region in 2020-2021.

The research was carried out in the crop rotation: 1) Fallow (pure, busy, chemical) 2) Spring wheat 3) Spring wheat 4) Spring wheat – according to the options of the experiment:

1) pure (black) fallow;
2) busy fallow (sudanese grass);
3) chemical fallow (Sprut Extra 54% - 2.5 l/ha+Dicamba 48% - 0.1 l/ha).

The area under each fallow field is 1.0 hectares with three replications (total under experience - 3.0 hectares). The area under crops of spring wheat is 3.0 hectares (one hectare after each fallow).

In the crops of spring wheat, a tank mixture of herbicides Ovsyugen Extra (0.6 l/ha)+Fenizan (0.2 l/ha) was used. The spring wheat variety Uralosibirskaya was cultivated, 5.5 million germinating seeds per hectare.

In the field of *pure* fallow, with the appearance of weeds (2nd decade of June and 3rd decade of July), cultivation was carried out - KPSh-9 by 10-12 cm and in the second decade of August - cultivation by 16-18 cm.

Busy fallow: sowing of Sudanese grass was carried out with a seeder

- SZS-2.1, rolling with rollers - 3KKSh-6; harvesting Sudanese grass for green forage - in the second decade of July, in the third decade of July - cultivation - KPSh-9 by 10-12 cm, in the second decade of August the second cultivation by 16-18 cm.

Chemical fallow: application of herbicides when weeds grow to a height of 15 cm - glyphosate containing Sprut Extra 54% - norm 2.5 l/ha+Dicamba 48% - 0.1 l/ha - two treatments (June - 3rd decade; July 3rd decade).

Sowing of spring wheat was carried out - SZS-2.1, spraying - with an Avagro sprayer, wheat harvesting - with an Esil 740 combine. Yield accounting - with recalculation for 100% purity and 14% grain moisture.

Field studies on the effect of the seeding rate on the yield of varieties and hybrids of spring rapeseed in the conditions of Northern Kazakhstan were carried out in the period from 2020 to 2021 on the basis of the Esil state grain-feed variety testing site, which is located in the village of Yavlenka, Esil district, North Kazakhstan region. On the experimental fields of the Esil state grain-feed variety testing site, a competitive test of spring rapeseed was carried out, represented by 5 varieties: Yubileiny - standard, Geros, Maikudyk, Hunter, Makhaon and 3 hybrids: Caliber, Bilder, GEN0009 [7, p. 17-22]. The study of varieties and hybrids was carried out according to several seeding rates, namely, 2 million viable seeds, 2.5 million viable seeds and 3 million viable seeds [10, p. 190-195]. The area of the accounting plot is 25 m^2, fourfold replication with 2 tiers in the experiment [6, p. 416], the predecessor - pure fallow.

According to the research results, the yield of spring wheat in 2020, placed after the studied fallows, ranged from 1.70 to 1.80 t/ha (table 1). In terms of net fallow, the yield exceeded by 0.05 t/ha (2.78%) in comparison with the busy fallow and by 0.10 t/ha (5.56%) than in chemical fallow. The difference between employed and chemical fallows was 0.05 t/ha.

Table 1
Yield of spring wheat cultivated on fallows, t/ha

| Fallow as predecessor | 2020 | 2021 | 2020-2021 | Relative to pure fallow (control) + - | | | | | |
| | | | | 2020 | | 2021 | | 2020-2021 | |
				t/ha	%	t/ha	%	t/ha	%
Pure (control)	1.80	2.06	1.93	-	100	-	100	-	100
Busy	1.75	2.01	1.88	-0.05	+2,78	-0,05	-2,40	-0,05	-2,59
Chemical	1.70	2.40	2.05	-0.10	+5,56	+0,36	+17,5	+0,12	+6,22
NSR$_{05}$	0.08	0.07							

In 2021, the highest yield of spring wheat (2.40 t/ha) was obtained for chemical fallow, which exceeds the control (pure fallow) by 0.36 t/ha and for busy fallow by 0.39 t/ha. In relation to the control, the wheat yield for the busy fallow is lower by 0.05 t/ha (2.4%), for the chemical fallow it is higher by 0.36 t/ha (17.5%).

The yield of spring wheat on average over two years of research for net fallow was 1.93 t/ha, for busy fallow it was lower than the control by 0.05 t/ha (2.59%), for chemical fallow it was higher by 0.12 t/ha (6.22%).

The highest productivity, when cultivating rapeseed for pure fallow, is provided by the option with a seeding rate of 2.0 million germinable seeds, with an increase in the rate, the yield decreases, in particular, 3.80 t/ha has a yield of the Bilder hybrid at a seeding rate of 2.0 million germinable seeds, with an increase in the seeding rate, its yield on average for two years decreased to 3.25 t/ha. Among the varieties, Maykudyk was distinguished with a yield of 3.76 t/ha, which exceeds the standard (Yubileiny) by 0.19 t/ha at a seeding rate of 2.0 million germinable seeds (table 2).

Table 2.
Productivity (t/ha) of varieties and hybrids of spring rapeseed, depending on the seeding rate, predecessor - pure fallow

Varieties/ hybrids	2020			2021			On average for 2020-2021			Deviation from the standard, t/ha		
	2 mill. germ. seeds (control)	2.5 mill. germ. seeds	3 mill. germ. seeds	2 mill. germ. seeds (control)	2.5 mill. germ. seeds	3 mill. germ. seeds	2 mill. germ. seeds (control)	2.5 mill. germ. seeds	3 mill. germ. seeds	2 mill. germ. seeds	2.5 mill. germ. seeds	3 mill. germ. seeds
Anniversary standard	4.02	3.80	3.60	3.12	3.05	2.74	3.57	3.43	3.17	-	-	-
Geros	3.81	3.70	3.50	2.78	3.01	2.53	3.29	3.36	3.02	-0.28	-0.07	-0.15
Maikudyk	4.20	4.01	3.81	3.32	3.24	3.12	3.76	3.63	3.47	0.19	0.3	0.3
Hunter	3.43	3.31	3.11	2.45	2.87	2.49	2.94	3.09	2.80	-0.63	-0.34	-0.37
Swallowtail	3.43	3.32	3.15	2.53	2.71	2.58	2.98	3.02	2.87	-0.59	-0.41	-0.3
Caliber	3.51	3.31	3.02	2.86	2.65	2.55	3.19	2.98	2.79	-0.38	-0.45	-0.38

Builder	4.28	4.17	3.82	3.32	3.09	2.68	3.80	3.63	3.25	0.23	0.20	0.08
GEN0009	3.42	3.23	3.01	2.60	2.69	2.43	3.01	2.96	2.72	-0.56	-0.47	-0.45
NSR 0.04				NSR 0.12								

Conclusions

1. According to the results of the 2020-2021 studies, the chemical fallow variant was characterized by a higher yield of spring wheat (2.05 t/ha) compared to the pure and busy fallows, and the excess was 0.36-0.39 t/ha over the pure and busy fallows.

2. For two years of research (2020-2021), the highest yield of spring rapeseed cultivated after pure fallow at a rate of 2.0 million germinating seeds was obtained from the Bilder hybrid (3.80 t/ha) and the Maikudyk variety (3.76 t/ha) with exceeding the standard 0.19-0.23 t/ha. An increase in the seeding rate leads to a decrease in the yield of rapeseed.

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