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REVIEW OF MODERN STRATEGIES UTILIZING PHARMACOLOGICAL INNOVATIONS IN PREVENTION OF DIABETIC COMPLICATIONS RELATED TO THE VISUAL SYSTEM

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Annotation: Today, diabetes mellitus (DM) is one of the priority medical and social problems, which is due to its epidemic prevalence and high disability of patients. Visual impairment is one of the disabling manifestations of diabetes. Thus, currently the leading cause of blindness among the working-age population has become diabetic retinopathy (DR), a late nonspecific vascular complication of diabetes.

Key words: Literature review, diabetes mellitus, diabetic retinopathy, prevention of retinopathy.

ОБЗОР СОВРЕМЕННЫХ СТРАТЕГИЙ ИСПОЛЬЗОВАНИЯ ФАРМАКОЛОГИЧЕСКИХ ИННОВАЦИЙ В ПРЕДУПРЕЖДЕНИИ ОСЛОЖНЕНИЙ САХАРНОГО ДИАБЕТА, СВЯЗАННЫХ С ЗРИТЕЛЬНОЙ СИСТЕМОЙ

Аннотация: Сегодня сахарный диабет (СД) является одной из приоритетных медико-социальных проблем, что обусловлено эпидемической распространенностью и высокой инвалидизацией больных. Нарушение зрения — одно из инвалидизирующих проявлений СД. Так, в настоящее время лидирующей причиной слепоты среди населения трудоспособного возраста стала диабетическая ретинопатия (ДР) — позднее неспецифическое сосудистое осложнение СД.

Ключевые слова: Обзор литературы, сахарный диабет, диабетическая ретинопатия, профилактика ретинопатии.

Relevance: Despite the widespread introduction of new effective drugs and instrumental methods for diagnosis and treatment, DR still remains the main cause of vision loss. There are different figures for the prevalence of DR in type 1 and type 2 diabetes mellitus in different countries. In patients with undiagnosed type 2 diabetes, signs of DR are detected at the time of diagnosis of the disease in 7 - 30% of patients. Moreover, proliferative DR is not a big problem for them, in contrast to type 1 diabetes, while diabetic maculopathy becomes the main cause of deterioration in visual acuity [1] .

The basic principle of treatment for DR is optimal compensation of diabetes and related problems: arterial hypertension and nephropathy, hyperlipidemia. The main way to prevent and slow the transition from preproliferative to subsequent stages of DR is strict control of glycemic levels. Currently, the optimal and most promising method of insulin injection for patients with DR seems to be an insulin pump, which is explained by a number of advantages, such as more accurate imitation of physiological insulin secretion, the possibility of more accurate glycemic control, a significant reduction in the risk of acute and long-term complications of diabetes, etc. Factors factors that contribute to the progression of diabetic retinopathy (DR) include the degree of compensation of carbohydrate metabolism, duration of diabetes, age, hypertension, nephropathy, pregnancy and smoking. DR is characterized by the presence of specific abnormalities of retinal vessels and tissues, such as changes in the caliber and tortuosity of retinal vessels, microaneurysms, hemorrhages, edema, exudates, new vessels and glial proliferation. The study of the morphological picture of DR revealed thickening of the basement

membrane, loss of capillary pericytes, acellularity of capillaries and impaired oxygen perfusion, which leads to the development of ischemia and hypoxia of the retina [2] .

The retina may be particularly susceptible to damage due to its high utilization rate of glucose and oxygen and the active glycolytic and anaerobic pathways of glucose metabolism [9]. Chronic hyperglycemia plays a key role in the development of DR, and data from multicenter studies indicate that maintaining normoglycemia significantly reduces the risk of microvascular complications. The results of the Diabetes Control and Complication Trial (DCCT, 1993) indicate a 76% reduction in the risk of developing diabetic retinopathy with satisfactory glycemic control. A UK multicentre study also found that normoglycemia and blood pressure control reduce the risk of diabetes complications and cardiovascular disease [3] .

Modern pharmacological advances provide significant opportunities for effective prevention of complications of diabetes mellitus, especially in relation to the visual system. In this article, we review the latest innovations and approaches in medical therapy aimed at preventing vision loss in patients with diabetes. From antioxidants to genetic technologies, our review covers a wide range of modern strategies that can reduce the risk of developing diabetic retinopathy and other visual complications .

Materials and methods: From official sources of the World Health Organization (WHO) and other medical studies, it follows that diabetes mellitus causes blindness in more than 2.6% of the world's working population. Data published in the Journal of Medical Economics and Pharmacoeconomics show that diabetic retinopathy occurs in more than 30% of patients with diagnosed diabetes. These figures highlight the critical relevance of research and development in pharmacological innovations for the prevention of visual complications of diabetes mellitus [4].

To compile an overview of modern approaches in the pharmacological prevention of complications of diabetes mellitus for the visual system, a thorough analysis of the available literature was carried out. As part of this analysis, electronic databases such as PubMed , Google Scholar and Web of Science , to search for current scientific articles, reviews and meta-analyses published in peer-reviewed journals. The terms “diabetes mellitus”, “visual system”, “diabetic retinopathy ”, “pharmacological prevention”, “new drugs” and other terms related to the topic of research were used as keywords . Next, the received articles were systematized and analyzed in order to identify modern innovations and approaches in the pharmacological prevention of diabetes complications for the visual system [9]. Based on the collected data, the following patterns can be determined in the treatment and prevention of diabetic retinopathy :

1. **Antioxidants and vitamins:** In recent years, considerable attention has been paid to the role of antioxidants and vitamins in the prevention of diabetic retinopathy . Antioxidants such as vitamin E , vitamin C, and carotenoids (including lutein and zeaxanthin) are effective in protecting against oxidative stress and inflammation in the retina. Oxidative stress plays a key role in the development of diabetic retinopathy , and antioxidants help reduce its level, which in turn slows down the progression of the disease [5].

2. **ACE inhibitors and ARBs:** Control of blood pressure plays an important role in preventing the development of diabetic retinopathy . Angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers (ARBs) effectively control blood pressure and also have a protective effect on retinal vessels. These drugs help reduce inflammation and capillary permeability , which helps preserve visual function.

3. **Autonomic receptor inhibitors and glucocorticoids :** Recent research shows promise for the use of autonomic receptor inhibitors, such as beta-blockers and alpha-blockers, in the prevention

of diabetic retinopathy . These drugs may help reduce the inflammatory response and suppress angiogenesis in the retina. The potential role of glucocorticoids in reducing inflammation and regulating the immune response in the retina, which may be useful in the prevention of diabetic retinopathy , is also being explored [6].

4. **Biologics:** New biologics, such as anti- VEGF (vascular endothelial growth factor inhibitors) and intraretinal steroids , show significant potential in the treatment and prevention of diabetic retinopathy. These drugs may help reduce angiogenesis , improve microcirculation, and reduce inflammation in the retina, which may help preserve visual function in patients with diabetes.

An example of how to describe the use of pharmacological agents at various stages of the disease:

1. Premature stage: In the early stages of diabetes, it is recommended to start taking antioxidants and vitamins to prevent further development of diabetic retinopathy . This will help reduce the level of oxidative stress and inflammation in the retina, preventing progression of the disease.

2. Advanced stage: At the stage of development of diabetic retinopathy, angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers (ARBs) can be effective . These medications will help control blood pressure and protect the retinal blood vessels from further damage.

3. Advanced stage with complications: In the presence of complications such as macular edema or retinal neoplasms, the use of biological drugs such as anti- VEGF and intraretinal steroid drugs is recommended . These products will help improve microcirculation and reduce inflammation in the retina, helping to preserve visual function.

4. Recovery period: After treatment of complications, it is important to continue to use antioxidants and vitamins to maintain visual health and prevent relapse of diabetic retinopathy . Regular medical monitoring and adjustment of treatment according to changes in the patient's condition also play an important role in maintaining visual function.

Treatment of DR is aimed at increasing the period from the moment of diagnosis of DM to the appearance of changes in the fundus, slowing down the transition from preproliferative to the next stages of the disease, leading to a significant decrease in visual functions and disability [7].

Treatment methods for DR depend on its stage, but the basic principle is optimal compensation for DM and associated problems - arterial hypertension and nephropathy, hyperlipidemia . This includes strict control of glycemic levels and adequate therapy for diabetes, such as diet, dosed exercise, glucose-lowering drugs and self-monitoring. The insulin pump is considered the most promising method of insulin injection in patients with DR , offering a more accurate simulation of physiological insulin secretion and the ability to more accurately control glycemia, which reduces the risk of complications of DM. For patients with mild DR, only regular examination is recommended [10]. Ophthalmological examination is carried out with different frequencies depending on the stage of DR : from 1 time per year in the absence of DR to 3-4 times per year in proliferative DR.

Laser photocoagulation is the main method of stabilizing the pathological process in preproliferative and proliferative DR ; the urgency of the procedure depends on the form and stage of the pathology.

Drug therapy is considered an adjunct to laser treatments for DR. Some drugs, such as fenofibrate, have shown significant results in the treatment of DR [8].

Results and discussions: It is necessary to conduct the first examination by an ophthalmologist 1.5 - 2 years from the onset of the disease in patients with type 1 diabetes and along with diagnosis in patients with type 2 diabetes. The first examinations in childhood begin at 10 years of age (from the onset of puberty).

If the disease progresses well, repeat examinations are carried out once a year, and if pathology is detected - once every 3-6 months. The frequency of examinations can be decided individually if there are additional risk factors such as pregnancy, nephropathies or arterial hypertension.

If there are complaints of a sudden decrease in visual acuity, the patient should be immediately referred to an ophthalmologist.

Conclusions: Thus, a promising direction in the treatment of diabetic retinopathy remains educating patients and doctors, achieving the highest possible degree of glucose and blood pressure control throughout the life of a patient with diabetes, providing patients with the most modern hypoglycemic drugs, including herbal drugs, and means of self-control , mandatory and timely screening and monitoring of patients, development of new effective drugs and treatment methods . As a result, modern pharmacological methods play a key role in the prevention and treatment of diabetes complications associated with the visual system. Antioxidants, angiotensin-converting enzyme (ACE) inhibitors and angiotensin II receptor blockers (ARBs), as well as new biologics, provide effective tools to protect retinal vasculature and improve visual function in patients with diabetes. These approaches hold promise for improving quality of life and reducing the risk of diabetes-related complications.

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