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Physical activity as a prescription for diabetic retinopathy

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Abstract

Introduction and purpose

Diabetic retinopathy is one of the leading causes of vision loss in diabetic patients. The purpose of this work is to confront the problem of retinopathy and present the beneficial effects of physical activity on retinal health in patients in this risk group.

State of knowledge

This paper reviews the literature on the problem of microangiopathic complications of diabetes, diabetic retinopathy, and the effect of physical activity on changing the incidence of this complication. According to the WHO, diabetic retinopathy is the leading cause of preventable blindness and visual impairment. Trends in diabetes and its associated complications are steadily increasing. Diabetic retinopathy occurs in about one-third of diabetics. It can be prevented by controlling blood glucose, blood pressure and lipid levels. Following a proper diet and physical activity can maintain adequate glucose levels, thereby reducing the incidence of diabetes complications.

Material and method

The literature available on Google Scholar and "PubMed" was reviewed. The focus was on presenting the problem of microangiopathic complications of diabetes mellitus detailing diabetic retinopathy, diagnosis, treatment methods, pathogenesis of the condition and prevention of this complication through the beneficial effect of regular physical activity in diabetic patients.

Summary

Our review succeeded in presenting the current status of the problem of retinopathy, the development of diagnosis and treatment of diabetic retinopathy. On the basis of a number of studies presented in this review, we managed to prove the positive aspect of physical exercise on prevention, treatment and reduction of the effects and complications of diabetes. In our review, we concluded that increasing physical activity in daily lifestyle is one of the methods of treating diabetes by lowering blood glucose levels, thereby reducing the risk of diabetic retinopathy as a complication of diabetes.

Keywords: Type 1 and 2 diabetes; Diabetic retinopathy; Physical effort; Complication of diabetes;

Introduction

Diabetes is a metabolic disease of civilization. According to the IDF, more than 537 million people worldwide have diabetes and in 2021 it was responsible for 6.7 million deaths.¹ There are two main types of diabetes. Type I diabetes leads to insulin deficiency through an autoimmune process, causing the destruction of pancreatic β -cells, while Type II, which is the most common form of the disease, is characterized by decreased insulin secretion and insulin resistance.² The disease causes a number of chronic serious complications including diabetic retinopathy.³ This is a dangerous complication that is highly likely to lead to vision loss.

Purpose

The purpose of this work is to show how changing daily lifestyle by including physical activity affects the complications, severity and reduction of the complication of type 1 and type 2 diabetes, which is diabetic retinopathy. The purpose of this work is to present such an important problem as diabetic retinopathy, methods of diagnosis, treatment, classifications through the analysis of scientific literature and relevant studies.

Material and methods:

The WHO-regulated term diabetic retinopathy is defined as a common complication of diabetes and one of the leading causes of visual impairment and blindness worldwide. It is estimated that diabetic retinopathy currently affects 126 million of the 382 million people with diabetes worldwide.⁴ Therefore, diabetic retinopathy is a serious public health problem. In wealthier regions, the incidence of severe retinopathy has declined despite the increasing number of patients with type I and type II diabetes.⁵ Greater attention to risk factors, expanded screening, and improved treatments for retinopathy are resulting in significant clinical improvements and reduced incidence of this complication.⁶⁻⁸ In our work, we will be looking at treatment methods including physical activity as one of the methods of treatment and prevention and progression of this complication of diabetes. For this purpose, we are reviewing publicly available article databases such as PubMed and Google Scholar.

Results

Our review succeeded in summarizing the diagnostic differentiation and presenting the latest forms of treatment for diabetic retinopathy. By reviewing a number of articles, we shed light on the beneficial effects of physical activity as one of the treatments for this complication of diabetes. Our analysis shows that physical activity is very beneficial in reducing the risk of diabetic retinopathy, causes a decrease in the severity of this complication, and reduces the symptoms of retinopathy in patients who already have this complication.

Retinopathy

Diabetic retinopathy is one of the many complications of diabetes that causes abnormalities within the retina. Blood vessels within the retina become damaged as a result of which they become blocked or leaky. Abnormal blood vessels can form in the retina, which can bleed or scar the retina resulting in permanent vision damage or blindness. Visual impairment occurs due to thickening within the central part of the retina, which can lead to loss of vision.⁹

Epidemiology and pathogenesis

Diabetic retinopathy is one of the chronic microvascular complications of diabetes and develops in most patients. The number of people suffering from diabetic retinopathy in 2020 was 103 million worldwide, and it is estimated to increase to 130 million in 2030 and 161 million in 2045.¹⁰ The duration of diabetes stands out as the main and strongest risk factor for diabetic retinopathy. In addition, the development of this complication is influenced by the maintenance of high glycemic concentrations and hypertension. The basis for the development of the process of this complication is endothelial dysfunction, caused by the activation of biochemical processes in hyperglycemia, and pathological endothelial proliferation.¹¹ High blood glucose levels lead to increased production of reactive oxygen species (ROS), resulting in the development of oxidative stress.¹¹⁻¹² This is followed by the release of growth factors including IGF-1, VEGF, PDGF which leads to the induction of new vessel formation in the retina. The final stage is a cascade of events leading to rupture of weakened and damaged vessels, followed by hemorrhage into the vitreous chamber, pre-retinal hemorrhage, macular edema, retinal detachment and neovascular glaucoma. The consequence is severe visual impairment.¹³ The WHO classifies retinopathy as follows: non-proliferative retinopathy without maculopathy, non-proliferative retinopathy with maculopathy, initial proliferative retinopathy and advanced proliferative retinopathy.

Diagnosis

According to the PTD, the first ophthalmologic examination in patients with type I diabetes should be performed within 5 years of diagnosis, while in patients with type II diabetes, the first examination is performed at the time of diagnosis. A comprehensive ophthalmologic examination in people with diabetes includes visual acuity testing, measurement of intraocular pressure, or tonometry, anterior and posterior examination and OCT of the macula.¹⁴

Classification

Diabetic retinopathy is divided into proliferative and non-proliferative.¹⁵ Non-proliferative diabetic retinopathy involves changes in the intraretinal microcirculation. In proliferative diabetic retinopathy, there is an increase in the number of newly formed often abnormal vessels on the retina or optic disc. Diabetic macular edema causes thickening of the retina in the posterior pole and can occur in both proliferative and non-proliferative diabetic retinopathy.¹⁶

Treatment

Patients with features of diabetic retinopathy should be scheduled for individual ophthalmic treatment. There are several forms of ophthalmic treatment for diabetic retinopathy. Anti-VEGF therapy, or preparations that block vascular endothelial growth factor. It is used in diabetic macular edema and proliferative retinopathy. Preparations such as ranibizumab, bevacizumab and aflibercept have proven efficacy in reducing diabetic macular edema and favorably improve visual acuity.¹⁷ Another dedicated treatment method is coagulation laser therapy. We use this form of treatment for proliferative and non-proliferative retinopathy. Vitrectomy is a microsurgical procedure that involves excision of the vitreous body. Indications for the procedure are massive nonabsorbable hemorrhages and severe

fibrovascular proliferation, which can be a complication of proliferative diabetic retinopathy.¹⁸⁻¹⁹

Of course, in the treatment and prevention of progression of retinopathy changes, in addition to ophthalmic treatment, consideration is given to maintaining adequate blood glucose levels, serum cholesterol levels, as well as strict control of blood pressure. For all diabetic patients, a healthy lifestyle, proper diet, normalization of BMI and daily physical activity (for patients with no medical contraindications) are recommended. This is especially true for people with type 2 diabetes, for whom activity 3-7 days a week is recommended, a minimum of 150-300 minutes a week of moderate activity or 75-150 minutes of vigorous activity, or an equivalent combination of these values.²⁰ Unfortunately, a sizable proportion of patients do not follow the recommendations and show little or no physical activity. According to the study (2008), the majority of respondents (72%) with type 2 diabetes, do not rest actively and are unaware of the use of physical exercise as a form of prevention of diabetes complications.²¹

Physical activity and its impact on the risk of diabetic retinopathy

Incorporating more physical activity into daily life has been shown to have a beneficial effect in delaying the onset and progression of diabetes complications.²² Physical inactivity accounts for about 27% of all causes of diabetes.²³ It is crucial in the occurrence of many diabetes complications such as nephropathy, neuropathy and diabetic retinopathy.²⁴ Physical activity has become the target of many studies as a treatment plan for diabetes and its complications. Many studies have proven how lack or negligible physical activity affects the increased incidence of diabetes complications with diabetic retinopathy singled out. The beneficial effect of physical activity in delaying and reducing the progression of diabetic retinopathy has been proven.²⁵⁻²⁷ Wang et al. (2019) conducted the Beijing Eye Study. It involved 3,468 participants. They found that increased physical activity was associated with a reduced incidence of diabetic retinopathy.²⁸ A study conducted by Aro et al. (2019) included 522 participants. This study evaluated whether lifestyle changes early in diabetes would have a beneficial effect on the incidence of diabetic retinopathy. They found a positive effect of incorporating physical activity into lifestyle as a diabetes treatment plan, delaying the progression or onset of diabetic retinopathy. The study found that those in the DPS intervention group showed a reduction in retinal microvascular abnormalities.²⁹ Gilbert et al. (2020) analyzed guidelines for the prevention and treatment of diabetic retinopathy in India. They found that lack of or poor control of high blood glucose and prolonged disease duration were major risk factors for retinopathy. This complication can be hindered by engaging in physical activity, they estimated.³⁰ Trott, Driscoll and Pardhan (2022) found that a sedentary lifestyle was associated with the risk of retinopathy.³¹ Kuwata et al. (2017) found that higher activity levels were associated with a lower incidence of retinopathy among Japanese patients with type 2 diabetes.³² Alramadan et al. (2019) studied 1121 patients with type 2 diabetes at three diabetes centers in Saudi Arabia, finding that lack of adequate physical activity increased the risk of diabetic retinopathy.³³ Bukht et al. (2019) demonstrated an association between physical activity and complications of type 2 diabetes in Bangladesh.³⁴ In a local hospital, 977 participants were randomly selected and in this group, an association between physical inactivity and diabetic retinopathy was discovered. This group of participants was classified as inactive.³⁴ Afroz et al (2019) in Bangladesh conducted a study in six diabetes

hospitals examining 1253 patients with type 2 diabetes. The study concluded that physical inactivity is a major risk factor for microvascular complications, and that increasing the frequency of physical activity is an important part of preventing diabetes complications.³⁵ Yan et al. (2021) conducted a study involving 9018 patients with diabetes, investigated the relationship between physical activity and the progression of retinopathy during a 10-year follow-up. They found that increased levels of physical activity were associated with a lower risk of increased diabetic retinopathy complications in this group.³⁶ The question of inactivity and the severity of diabetic retinopathy is still unclear. Praidou et al. (2017) found that increased physical activity affects a less severe degree of diabetic retinopathy. The study included 240 patients with type 2 diabetes, 80 patients with mild to moderate nonproliferative diabetic retinopathy, 80 patients with severe to very severe non-proliferative diabetic retinopathy and 80 with proliferative diabetic retinopathy. They were compared with 80 patients without diabetes, constituting the control group.³⁷ Ren et al. (2019) found that in patients with diabetes, physical activity has a protective effect on the risk of diabetic retinopathy, and the effect was found to be stronger for severe forms of retinopathy.³⁸ Tikkanen-Dolenc et al. (2020) found that frequent leisure-time physical activity was associated with a lower incidence of severe retinopathy in type 1 diabetes.³⁹ Hassabi et al. (2020) studied the relationship between physical activity and the severity of diabetic retinopathy. They found that lower levels of physical activity were a factor in more severe stages of diabetic retinopathy, in contrast to people with moderate physical activity. In this study, they suggest that physical activity reduces the risk of retinopathy by lowering BMI and achieving better glycemia.⁴⁰ Shein et al. (2020) conducted the Jiangsu Diabetic Eye Disease Study, which investigated the causes, prevalence, risk factors for moderate or severe visual impairment and blindness in patients with type 2 diabetes over the age of 50 in Funing County, Yancheng, China. The study included 1,909 participants from 85 centers. It found that diabetic retinopathy was the second leading cause of visual impairment and blindness after cataracts. Many risk factors were cited for both, including physical inactivity.⁴¹

Discussion

Diabetic retinopathy has become one of the most common causes of disability, loss of work due to complications in the form of visual impairment including blindness. Inactivity, failure to adhere to a diet, failure to control blood sugar and the associated excessively high blood glucose levels and increased blood pressure are closely linked to the higher incidence of diabetic retinopathy diagnosis among patients with type 1 and type 2 diabetes. Limited access to diagnostic procedures and lack of systematicity of screening for diabetic retinopathy waste the opportunity to prevent the development of retinal disease and blindness in these patients. Addressing these factors, promoting a healthy, active lifestyle, a balanced diet, and drawing attention to the issue of retinopathy screening is crucial to mitigating and avoiding the incidence of diabetic complications such as diabetic retinopathy.

Conclusion

In this review, we demonstrated the huge role of physical activity in the prevention of diabetes complications as serious as retinopathy. Daily physical activity lowers the risk and slows the progression of this condition by normalizing blood glucose and BMI. Studies also prove that it definitely improves circulation in the retinal vessels, and this translates into a

reduced risk of macular degeneration and improved visual acuity. Our work also proves the beneficial effect of physical activity in people who already have this complication, i.e. those with mild, moderate and severe diabetic retinopathy.

The research shows the importance of including a healthy lifestyle as a form of supportive treatment for both newly diagnosed diabetes and diabetes with existing ocular complications. We did not include articles that indicate a negative or zero effect of physical activity on the risk of diabetic retinopathy, as we did not come across such articles. In conclusion, physical activity has a beneficial effect on retinal health in patients with type 1 and type 2 diabetes, including the diabetic retinopathy considered in the article.

DISCLOSURE

Author's contribution

Conceptualization, Dominika Poborowska and Weronika Kahan; methodology, Weronika Szafrńska; software, Marta Wojaczek; check, Marta Wojaczek and Katarzyna Polańska; formal analysis, Emilia Bąk and Oliwia Najjar; investigation, Jacek Fordymacki and Oliwia Najjar; resources, Tomasz Gańko; data curation, Weronika Szafrńska; writing - rough preparation, Weronika Kahan; writing - review and editing, Kasia Polańska; visualization, Dominika Poborowska; supervision, Katarzyna Polańska and Jacek Fordymacki; project administration, Emilia Bąk and Tomasz Gańko; receiving funding - no specific funding.

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The data presented in this study is available upon request from the correspondent author.

Conflict of interest

The authors deny any conflict of interest

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