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Research Article

Glaucoma and Type 2 Diabetes

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Abstract

Primary open-angle and angle-closure glaucoma and type 2 diabetes are some of the most common causes of blindness in the modern world.

Glaucoma is divided into primary and secondary. We also distinguish between primary open-angle glaucoma (POAG) and primary angle-closure glaucoma (JPZK) depending on the mechanism of obstruction of the outflow of aqueous humor and the width of the filtration angle. Primary open angle glaucoma is the second most common cause of blindness worldwide.

According to prof. JJ Kański Primary open-angle glaucoma (POAG) is characterized by an open angle of filtration, an increase in intraocular pressure above 21 mm Hg, glaucomatous damage to the optic nerve disc, defects in the visual field and occurs in adulthood.

Primary angle closure glaucoma (POA) is a disease associated with increased intraocular pressure resulting from blocking the outflow of aqueous humor from the eye by partial or complete closure of the filtration angle through the peripheral part of the iris. High intraocular pressure can cause an acute attack of glaucoma, and repeated attacks of acute glaucoma or its chronic form can lead to optic neuropathy and blindness.

Glaucoma is one of the main causes of irreversible blindness in highly developed countries. It is the cause of approximately 12% of all cases of total vision loss. It is estimated that by 2020 the number of glaucoma patients was approximately 80 million people, and approximately 8.4 million people lost their sight due to this disease.

Introduction

Type 2 diabetes is the most common metabolic disorder characterized by fasting hyperglycemia and elevated blood and urine glucose levels after an oral glucose load.

Diabetes is a multifactorial disease that leads to damage to internal organs such as the eyesight, kidneys, heart muscle, nervous system and limbs. 20% of diabetic patients develop diabetic retinopathy. The incidence of type 2 diabetes increases with age. Due to the constant increase in disease incidence, a

pandemic is expected in the coming years. According to WHO, by 2025 the number of people with diabetes in the world will double and reach 300 million people.

Both glaucoma and type 2 diabetes are diseases whose incidence increases after the age of 40. A significant number of patients are unaware of the fact that they suffer from one of these diseases. In both of these diseases, emotional stress causes hyperglycemia in diabetes and high intraocular pressure in glaucomatous eyes.

Aim

The relationship between BMI (Body Mass Index) and the presence or absence of primary open-angle or closed-angle glaucoma in patients with type 2 diabetes.

These goals were achieved by assessing changes in glaucoma parameters depending on:

- On the duration of the disease, the presence of co-occurrence of primary open-angle glaucoma and type 2 diabetes, the co-occurrence of diabetic retinopathy, the presence of hypertension, changes in such parameters as morphology, lipid profile, creatinine level, eGFR level, potassium and glucose levels.

This goal was achieved by assessing parameters such as:

- Visual acuity, tonometry, gonioscopy, assessment of the anterior segment, assessment of the posterior segment, optical coherence tomography (OCT – GDX, HRT, OCT of the macula, filtration angle imaging commonly called OCT – gonioscopy), pachymetry, perimetry, BMI assessment, morphology, lipid profile, creatinine level, eGFR, potassium and glucose levels.

Materials and Methods

Characteristics of the studied group of patients

The retrospective analysis of the studies was carried out on the basis of medical records of patients treated at NZOZ Oko Lens in Gdańsk. The observation period lasted 31 months. The analyzed group of patients included 30 patients with type 2 diabetes.

Inclusion and exclusion criteria

The following were randomly selected for the study from the medical records of the NZOZ Oko Lens:

- 30 patients,
- 60 eyes,
- 20 women and 10 men,
- with type 2 diabetes lasting 10-15 years,
- aged between 50-70 years.

The criteria for excluding a patient from the analyzed group were:

- previous or current thyroid diseases,
- other metabolic diseases,
- intraocular operations performed during the study period (cataract surgery, vitrectomy),
- mental diseases,
- lack of consent to participate in the study,
- other diseases affecting the condition of the organ of vision.

Statistical Methods

The analyzed material included quantitative and qualitative features. The data was saved in a Microsoft Excel spreadsheet. Personal data were coded and the data was used in the further analysis process without disclosing personal data.

Statistica 12 (StatSoft, USA) was used in the statistical analysis.

In the statistical description of quantitative data, location measures were used: arithmetic mean and median, and the assessment of the diversity of results was made using the standard deviation. The Shapiro-Wilk test was used to verify the hypothesis about the normality of the distribution of the studied variables. When

comparing the arithmetic mean between groups, depending on the distribution of results, a test based on the Student's t-Distribution statistic for equal or different variances or the non-parametric Mann-Whitnehy U test was used.

Structure indicators were used to present the regularity of qualitative data. The study of the relationship between qualitative characteristics was based on four-field or multi-field contingency tables using the chi-square independence test with or without Yates' correction, respectively. In all statistical tests, the level of statistical significance was assumed to be $p \leq 0.05$.

Results

Data from the interview

Diabetic retinopathy and the occurrence of glaucoma

Analyzing eyes with glaucoma, it was found that diabetic retinopathy did not occur in these eyes, while in eyes without glaucoma, diabetic retinopathy occurred in every third patient, as shown in the table.

Diabetic retinopathy	**Eyes with glaucoma**		**Eyes without glaucoma**	
	number	%	number	%
Yes (RCNP)	-	-	10	33.3
No (without RC)	thirty	100.0	20	66.7
Together	thirty	100.0	thirty	100.0

Table.1. Diabetic retinopathy and the occurrence of glaucoma

Diabetes

Anterior chamber depth and the occurrence of diabetic retinopathy

Analyzing the depth of the anterior chamber and the occurrence of diabetic retinopathy, a statistically significant relationship was found between the dimensions of the anterior chamber and the occurrence of diabetic retinopathy (chi square = 9.007 p = 0.015). In eyes without retinopathy, it was most often shallow,

while in eyes with retinopathy, it was most often medium or deep, as shown in Table 2.

Chamber	**Without RC**		**RCNP**	
	number	participation (%)	number	participation (%)
Very shallow	2	4.0	-	-
Plate	32	64.0	2	20.0
Medium deep	14	28.0	6	60.0
Deep	2	4.0	2	20.0
Together	50	100.0	10	100.0

Table 2. Anterior chamber depth and the occurrence of diabetic retinopathy

The ratio of the recess to the size of the disc (c/d) in individual groups

Analyzing the ratio of the cavity to the size of the disc in the group with and without glaucoma, it was found that the average c/d ratio in eyes with glaucoma was 0.42 (±0.21) and was significantly different from the average degree of patients without glaucoma, in whom it was 0 .18 (±0.09, t=5.608 p<0.001), as shown in Table 3.

c/d	**Glaucoma**		**No glaucoma**	
	number	Participation (%)	number	participation (%)
0.1	3	10.0	14	46.7
0.2	5	16.7	10	33.3
0.3	4	13.3	4	13.3
0.4	6	20.0	2	6.7
0.5	4	13.3	0	0.0
0.6	2	6.7	0	0.0
0.7	4	13.3	0	0.0

0.8	2	6.7	0	0.0
Together	thirty	10.0	thirty	100.0
Mean	0.42		0.18	
Median	0.40		0.20	
Standard deviation	0.21		0.09	
Min.	0.10		0.10	
Max.	0.80		0.40	

Table. 3. The ratio of the recess to the size of the disc (c/d) in individual groups

Macular OCT and the occurrence of diabetic retinopathy.

Analyzing the retinal thickness in the macula using OCT, a statistically significant relationship was found between the retinal thickness in the macula and the occurrence of diabetic retinopathy (chi square=3.341 p=0.034). The mean macular retinal thickness in eyes without retinopathy was 182.28 (±22.16) and was lower than the mean retinal thickness in eyes with retinopathy, which was 208.60 (±42.94), as shown in Table 4 and in chart 1.

OCT	**Without RC**		**RCNP**	
	number	participation (%)	number	participation (%)
200 or less	39	78.0	5	50.0
over 200	11	22.0	5	50.0
Together	50	100.0	10	100.0
Mean	182.28		208.60	
Median	184.00		204.50	
Standard deviation	22.16		42.94	
Min.	133.00		159.00	
Max.	231.00		294.00	

Table 4. OCT of the macula and the occurrence of diabetic retinopathy

OCT imaging of the filtration angle and the occurrence of diabetic retinopathy

Analyzing the imaging of the filtration angle using OCT (commonly called OCT-gonioscopy), it was found that in diabetic retinopathy the filtration angle in OCT gonioscopy was wide open in 70% of the eyes (chi square = 4.346 p = 0.057), in eyes without diabetic retinopathy in 64% was narrow, as shown in Table 5.

Gonioscopy	**Without RC**		**RCNP**	
	number	Participation (%)	number	participation (%)
Very narrow angle (0-10 degrees)	6	12.0	0	0.0
Angle moderately narrow (11-20 degrees)	26	52.0	3	30.0
Wide open angle (over 20 degrees)	18	36.0	7	70.0
Together	50	100.0	10	100.0

Table 5. Angle imaging and the occurrence of diabetic retinopathy

BMI (body mass index) in individual groups.

Analyzing BMI in individual groups, a statistically significant relationship was found between the occurrence of glaucoma and the BMI level (chi square = 9.127 p = 0.014). Obesity I and II degree was more common in patients without glaucoma, as shown in Table 6.

BMI	Glaucoma		No glaucoma	
	number	participation (%)	number	participation (%)
Correct weight	10	33.3	6	20.0
Overweight	10	33.3	4	13.3
Obesity grade I	4	13.4	14	46.7
Obesity stage II	6	20.0	6	20.0
Together	thirty	100.0	thirty	100.0

Table 6. BMI in individual groups in 2013

A statistically significant relationship was found between the occurrence of glaucoma and the BMI level (chi square = 9.127 p = 0.014). Obesity was more common in patients without glaucoma, as shown in Table 7.

BMI	**Glaucoma**		**No glaucoma**	
	number	participation (%)	number	participation (%)
Correct weight	6	20.0	4	13.3
Overweight	14	46.7	6	20.0
Obesity class I	6	20.0	10	33.3
Obesity stage II	4	13.3	10	33.3
Together	thirty	100.0	thirty	100.0

Table 7. BMI and the incidence of glaucoma in 2019

In 2019, a higher incidence of grade I and II obesity was found in the group without glaucoma compared to the group with glaucoma.

Lipidogram and BMI

Analyzing the lipidogram and BMI, a statistically significant relationship was found between the BMI level and the lipidogram (chi square = 7.237 p = 0.033), it was more often abnormal in patients with obesity, as shown in Table 8.

Lipidogram	**Glaucoma**		**No glaucoma**	
	number	participation (%)	number	participation (%)
Normal	20	66.7	18	60.0
Incorrect	10	33.3	12	40.0
Together	thirty	100.0	thirty	100.0

Table 8. Lipidogram and the occurrence of glaucoma in 2019

In 2019, there was also no statistically significant relationship between the occurrence of glaucoma and the normality of the lipid profile (chi square = 0.287 p = 0.592).

In 2019, in the group of glaucoma patients, the share of people with normal lipid profile was 66.7% and was 20 points higher compared to 2015. percent the change is statistically insignificant (p=0.1257).

In 2019, in the group of patients without glaucoma, the share of people with normal lipid profile was 60.0% and was 20 points higher compared to 2015. percent the change is statistically insignificant (p=0.1213).

Polyneuropathy in the group with and without glaucoma

When analyzing the occurrence of polyneuropathy in the group with and without glaucoma, a statistically significant relationship was found between the occurrence of glaucoma and polyneuropathy (chi square = 10.00 p = 0.001). It occurs more often in patients without glaucoma. The results are presented in Chart 2.

Discussion

Primary open-angle and angle-closure glaucoma and type 2 diabetes are among the most common causes of blindness in the modern world. The increasing incidence of diabetes has reached epidemic levels in developed and developing countries. It is predicted that by 2030, 6.4% of the population will suffer from diabetes.

The examined material was divided into two groups: Group A included patients with primary open-angle glaucoma or primary narrow-angle glaucoma and concomitant type 2 diabetes , and Group B - without glaucoma , with type 2 diabetes.

Our own research concerned observations of patients with primary open-angle and closed-angle glaucoma and type 2 diabetes, in whom the average age of a glaucoma patient was 65.2 years. The average age of the patient without glaucoma was 63.2 years, and half were no older than 63 years.

In the research material, diabetes was detected in eyes with glaucoma at the age of 54.5 years (±4.44). In eyes without glaucoma, diabetes was diagnosed on average at the age of 51.6 years (±5.01), and half of them were no older than 52 years. Patients without glaucoma were significantly younger at the time of diagnosis of diabetes than those with glaucoma. Patients without glaucoma, on average, had diabetes longer than those with glaucoma.

Analyzing the eyes of patients with JPZK glaucoma, it was found that at the time of glaucoma detection they were on average 62.64 years old (±6.51), and those with JPOK glaucoma were on average 59.00 years old (±6.14). In our own research, it was observed that the duration of glaucoma in the eyes of patients with both JPZK and JPOK glaucoma was on average 3.55 years. Among the examined eyes, eyes with JPZK glaucoma predominated (73.3% of eyes).

Diabetic retinopathy did not occur in eyes with glaucoma, while in eyes without glaucoma, diabetic retinopathy occurred in every third patient. Diabetic retinopathy occurs in approximately 33% of patients with type 2 diabetes in Thailand [99]. Polish scientists investigated the impact of the insertion/deletion polymorphism of the angiotensin I converting enzyme (ACE) gene on the development of diabetic retinopathy. They found that the ACE gene insertion/deletion polymorphism influences the progression of diabetic retinopathy [73].

Scientists: Yangjiani Li, William Mitchell, Tobias Elze, Nazlee Zebardast in 2020 found that the eyes of diabetic patients with glaucoma were almost three times more likely to develop diabetic retinopathy compared to the eyes of diabetics without glaucoma. Prospective studies may be required to establish a risk-cause relationship. Monitoring ocular perfusion pressure should be considered in patients with diabetes and glaucoma.

Conclusion

The results of this work show that:

1. Patients with primary open-angle or closed-angle glaucoma and type 2 diabetes have a lower BMI than patients without glaucoma and only type 2 diabetes.
2. Diabetic retinopathy did not occur in patients with glaucoma, therefore it can be concluded that the presence of glaucoma may delay the appearance of diabetic retinopathy.
3. Analyzing the lipid profile and BMI, it was found that it was more often abnormal in obese patients, from which it can be concluded that high BMI causes lipid profile disorders.
4. Polyneuropathy occurs more often in patients without glaucoma and with type 2 diabetes, which suggests that the presence of glaucoma may delay the development of polyneuropathy.

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