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Effect of type 2 diabetes mellitus on visual field defect, retinal nerve fiber layer (RNFL) thickness and intraocular pressure index in patients with primary open angle glaucoma.

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Abstract

Objective: To investigate the effects of type 2 diabetes mellitus on visual field defect, retinal nerve fiber layer thickness and intraocular pressure index in patients with primary open angle glaucoma.
Methods: A total of 125 patients (125 eyes) diagnosed with primary open-angle glaucoma in our hospital from April 2016 to September 2017 were enrolled as the research subjects. Patients were divided into case group (70 cases) and control group (55 cases). Patients in case group were diabetic patients combined with primary open-angle glaucoma, while the control group consisted of patients only with primary open-angle glaucoma. Mean defect of visual field, mean light sensitivity in visual field, retinal nerve fiber layer thickness and intraocular pressure index were compared between two groups.
Results: Mean defect of visual field in case group was (17.26 ± 3.15 dB), which was significantly higher than that in the control group (P<0.05). Mean light sensitivity in case group was (14.98 ± 4.27 dB), which was significantly lower than that in control group (P<0.05). Compared with control group, thickness of retinal nerve fiber layer at superior and inferior quadrants was lower than that in case group (P<0.05). There was no significant difference between the two groups in thickness of temporal, nasal and peripheral quadrant (P>0.05). Intraocular pressure of case group was (22.75 ± 2.61 mmHg), which was significantly higher than that of control group (P<0.05).
Conclusion: Type 2 diabetes can increase defect area of visual field, increase intraocular pressure, reduce retinal nerve fiber layer thickness and promote the progression of the disease in patients with primary open angle glaucoma.

Keywords: Type 2 diabetes mellitus, Primary open angle glaucoma, Visual field defect, Retinal nerve fiber layer thickness, Intraocular pressure.

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Introduction

Primary open angle glaucoma is a common disease that can lead to blindness. This disease usually affects adults aged 20-60. In addition to the degeneration of local anatomy, hypertension, diabetes and myopia may also lead to the occurrence of this disease [1]. A survey has suggested that [2] the incidence rate of primary open-angle glaucoma in diabetic patients is about 4%-11%, which was 3 times that in non-diabetes patients. Diabetes may cause different degrees of changes in fine structure of trabecular meshwork, hardened anterior chamber angle, blocked aqueous outflow as well as reduced trabecular size, resulting in rapid increase of sugar content in aqueous humor, change of osmotic pressure and increased intraocular pressure [3,4]. In addition, aging and prolonged course of diabetes may also increase the risk of primary open-angle glaucoma [2]. The combination of type 2 diabetes and primary open-angle glaucoma not only damages the vision of patients, but also reduces the quality of life and even leads to blindness in severe cases [5]. In order to make an in-depth research on the effect of type 2 diabetes on patients with primary open-angle glaucoma, we enrolled 125 patients diagnosed with primary open-angle glaucoma in our hospital from April 2016 to September 2017 to serve as subjects, and the effects of diabetes on visual field defect, retinal nerve fiber layer thickness as well as intraocular pressure were explored.

Subjects and Methods

Subjects

A total of 125 patients (125 eyes) diagnosed with primary open-angle glaucoma in our hospital from April 2016 to September 2017 were enrolled as the research subjects. Inclusion criteria: (1) patients were diagnosed with primary open-angle glaucoma by relevant nationwide standards developed in 1995 and the diagnosis of diabetes was in line with the diagnostic criteria established by Chinese Medical Association; (2) intraocular pressure was maintained at 21.50~33.60 mmHg with no obvious abnormality found in examination under slit lamp; (3) patients supported the study and signed informed consent. Exclusion criteria: (1) patients with severe cardiovascular or metabolic diseases; (2) patients with lesions of important organs or non-diabetic neuropathy; (3) patients who were taking drugs affecting heart rate and nerve conduction before examination. Those 125 patients were divided into case group (70 cases) and control group (55 cases). Case group included diabetic patients combined with primary open-angle glaucoma, while control group included patients only with primary open-angle glaucoma. The difference in Fasting Plasma Glucose (FPG) between the two groups was statistically significant (P<0.05), but there was no significant difference in gender, age and pathological changes between two groups (P>0.05, Table 1).

Table 1. *Comparison of general data between the two groups.*

Group	n	Male/female	Age (y)	Left/right eye	FPG (mmol/L)
Case group	70	36/35	56.2 ± 4.5	37/33	10.86 ± 2.34
Control group	55	28/27	56.4 ± 4.7	29/26	6.09 ± 0.93
χ2/t		0.682	0.541	0.473	8.925
p		>0.05	>0.05	>0.05	<0.05

Methods

Mean defect and mean light sensitivity of visual field were recorded. Optical Coherence Tomography (OCT) was performed to measure RNFL thickness. The area within 2.27X disc around optic disc was scanned. Images were processed using RNFL Thickness Average image analysis software to calculate average RNFL. RNFL thickness of superior, inferior, temporal, nasal and peripheral quadrants was measured 3 times a day by the NT-510 non-contact tonometer (NIDEK company, Japan), and the average value was calculated. All measurements were performed using double-blind methods.

Statistical methods

SPSS 22 software was used for data analysis. Count data, including gender, age and diseased eye were assessed by χ^2 test. Measurement data including plasma glucose, visual field defect, retinal nerve fiber layer thickness and intraocular pressure were analysed by t-test, P<0.05 indicated statistically significant difference.

Results

Comparison of visual field index between the groups

Mean defect of visual field in case group was (17.26 ± 3.15 dB), which was significantly higher than (12.08 ± 3.04 dB) in control group, that was (P<0.05). Mean light sensitivity in case group was (14.98 ± 4.27 dB), which was significantly lower than (18.03 ± 4.91 dB) in control group, that was (P<0.05, Table 2).

Table 2. *Comparison of visual field index between the two groups ($\bar{x}$ ± s).*

Group	n	Mean defect of visual field (dB)	Mean light sensitivity (dB)
Case group	70	17.26 ± 3.15	14.98 ± 4.27
Control group	55	12.08 ± 3.04	18.03 ± 4.91
t		8.041	7.623
p		<0.05	<0.05

Comparison of retinal nerve fiber layer thickness between the two groups

Compared with control group, the thickness of retinal nerve fiber layer at superior and inferior quadrants was significantly lower in case group (P<0.05), and there was no significant difference between the two groups in thicknesses of temporal, nasal and peripheral quadrants (P>0.05), as shown in Table 3.

Table 3. *Comparison of retinal nerve fiber layer thickness between two groups ($\bar{x}$ ± s, μm).*

Quadrants	Case group (n=70)	Control group (n=55)	t	p
Superior	123.85 ± 9.12	127.34 ± 9.81	4.977	<0.05
Inferior	123.62 ± 8.75	135.49 ± 11.02	5.085	<0.05
Temporal	79.43 ± 7.55	81.92 ± 9.06	1.016	>0.05
Nasal	76.57 ± 8.04	77.62 ± 7.65	0.953	>0.05
Peripheral	102.41 ± 6.16	103.64 ± 8.91	0.831	>0.05

Comparison of intraocular pressure between the two groups

Intraocular pressure of the case group was (22.75 ± 2.61 mmHg), which was significantly higher than (20.07 ± 1.94 mmHg) of the control group (t=5.628, P<0.05).

Summary: Mean defect of visual field in the case group was (17.26 ± 3.15 dB), which was significantly higher than (12.08 ± 3.04 dB) in control group (P<0.05). Mean light sensitivity in case group was (14.98 ± 4.27 dB), which was significantly lower than (18.03 ± 4.91 dB) in control group (P<0.05). Compared with control group, thickness of retinal nerve fiber layer at superior and inferior quadrants was lower in case group (P<0.05), and there was no significant difference between the two groups in the thicknesses of temporal, nasal and peripheral quadrants (P>0.05). Intraocular pressure of case group was (22.75 ± 2.61 mmHg), which was significantly higher than (20.07 ± 1.94 mmHg) of the control group (P<0.05). These results suggest that type 2 diabetes can increase defect area of visual field, enhance intraocular pressure, reduce retinal nerve fiber layer thickness and promote the progression of the disease in patients with primary open angle glaucoma.

Discussion

Primary open-angle glaucoma is one of the main causes of blindness with no obvious symptoms in the early stage, [6,7]. Patients with the primary open-angle glaucoma are usually accompanied by type 2 diabetes mellitus. In general, insulin resistance and poor blood glucose control can increase the incidence of primary open angle glaucoma. Primary open-angle glaucoma is a chronic progressive optic neuropathy with unknown pathogenesis, and the major risk factor for this disease is the elevated intraocular pressure [8,9]. Increased blood glucose can lead to changes of osmotic pressure as well as elevation of aqueous humor and intraocular pressure. Occurrence of primary open-angle glaucoma in diabetes is mainly induced by abnormal fine structure of trabecular meshwork, hardening anterior chamber angle, blocked aqueous outflow and reduced trabecular hole diameter as well as changed osmotic pressure caused by increased blood sugar. Studies have shown that occurrence of primary open-angle glaucoma is positively correlated with family history, age, body mass index, hypertension and diabetes. Retinal nerve fiber layer thickness, which is mainly dependent on number of ganglion cell axons, is clinically recognized as an indicator reflecting changes in visual cells and visual transduction [10-12]. In this study, visual field, optic nerve fiber layer thickness and intraocular pressure were compared between patients with only primary open-angle glaucoma and patients combined with diabetes. In this study, 70 patients were diagnosed with diabetes, accounting for 56% of all the patients. Retinal nerve fiber layer thickness was assessed by optical coherence tomography, which can clearly show the thickness around the optic disc [13]. This study revealed that the case group had significantly higher intraocular pressure and more serious mean defect of visual field than control group, suggesting that patients with diabetes are more prone to be affected by optic nerve defect than non-diabetic patients possibly due to the effect of vascular injury on retinal circulation. This hypothesis has been proved by a previous study [14]. Meanwhile, comparison of retinal nerve fiber layer thickness between two groups showed significant differences in RNFL thickness of superior and inferior quadrants, and the peripapillary RNFL thickness was highest in the inferior quadrant followed by superior, temporal and nasal quadrant, which were consistent with the anatomic findings. RNFL thickness of superior and inferior quadrants was lower in case group than in control group. The possible explanation is that those patients had already experienced apoptosis of retinal nerve cells during the development of diabetes. A previous study [15] showed that 4 months of blood sugar control was enough to reduce peripapillary RNFL thickness to certain degrees in each quadrant, especially in the superior, which is consistent with the findings in this study. Those data suggest that damage of various tissues like retinal ganglion is gradually aggravated during the progression of diabetes and that the thickness of RNFL can reflect the occurrence and development of the disease. Diabetes can lead to functional lesions of retinal nerve, thus aggravating original underlying diseases. But there are also some shortcomings in this research, for example, the degree of diabetes varied in the subjects and there was no analysis on mean visual field defect of patients with intraocular hypertension in case group. Retinal nerve fiber layer thickness decreases with the increased severity of the disease. Furthermore intraocular pressure is generally measured during the day time, but damage of optic nerve is a continuous process and the pressure may change during the sleep time. Above-mentioned defects will be avoided in our future studies.

In conclusion, type 2 diabetes can increase defect area of visual field, enhance intraocular pressure, reduce retinal nerve fiber layer thickness and promote the progression of the disease in patients with primary open angle glaucoma.

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