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RESEARCH ARTICLE

Association between glycemic control and intraocular pressure in patients with Type II diabetes mellitus

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ABSTRACT

Background: Diabetes mellitus is becoming an epidemic in our country and worldwide. It is an important risk factor for raised intraocular pressure (IOP). Raised IOP is associated with a potentially blinding condition known as glaucoma. Identification of factors, which increase the risk of glaucoma, is a mainstay in the early detection and prevention of blindness due to the disease. **Aim and Objectives:** To investigate the association between glycemic control and IOP in patients of Type II diabetes mellitus. **Materials and Methods:** The study included 180 participants. Group I included 80 age- and sex-matched normal healthy participants constituting the control group. Group II consisted of 100 diabetic patients. Group II was further subdivided into 3 subgroups according to glycemic control: Group IIA consisted of 36 patients diagnosed with Type II diabetes mellitus with hemoglobin A1c (HbA1C) levels <7% indicating good glycemic control, Group IIB consisted of 34 patients diagnosed with Type II diabetes mellitus with HbA1C levels between 7% and 8% indicating fair glycemic control, and Group IIC consisted of 30 patients diagnosed with Type II diabetes mellitus with HbA1C levels >8% indicating poor glycemic control. The patients were investigated for fasting blood glucose levels, postprandial blood glucose levels, and HbA1C. All participants underwent routine ocular examination including IOP measurement by Goldmann applanation tonometer. **Results:** The mean IOP in fasting state was statistically significantly lower than IOP in postprandial state ($P < 0.005$). The mean IOP of patients of Group II was higher than Group I ($P < 0.005$). The mean IOP of group IIA ,IIB and IIC were 16.9±0.43 mm of Hg,17.6±0.62 mm of Hg and 18.62±0.22 mm of Hg respectively. Patients with poor glycemic control had a higher IOP. The difference of IOP was found to be statistically significant ($P < 0.005$). **Conclusion:** The diabetic patients are prone to higher IOP, and especially, the patients with poor glycemic control were more prone to raised IOP. Diabetic patients should be regularly screened for IOP so that burden ocular morbidity due to glaucoma can be reduced.

KEY WORDS: Glycemic Control and Intraocular Pressure; Diabetes Mellitus and Intraocular Pressure; Blood Glucose Level and Intraocular Pressure; Hemoglobin A1c and Intraocular Pressure

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INTRODUCTION

The number of diabetics is growing fast and gaining a status of epidemic in India and worldwide. The disease is currently affecting 62 million people in India, and it is predicted that by the year 2030, the number will grow up to 79.4 million.[1-4] Looking at current scenario identification of factors which

lead to diabetes as well factors that are worsened by diabetes is necessary. Chronic hyperglycemia in diabetes is associated with long-term damage and dysfunction of multiple organs. Various microangiopathic complications associated with diabetes are nephropathy, retinopathy, and neuropathy.[5] Diabetes is a known risk factor of decreased visual acuity, and diabetic retinopathy is a well-established cause of it.[6,7] It has been documented that tight control of blood glucose levels reduces the risk of retinopathy.[7] Diabetes besides having an effect on the retina is also a risk factor for raised intraocular pressure (IOP). A number of studies have shown the association of diabetes mellitus with glaucoma.[8,9] Whether tight glycemic control prevents the rise in IOP is the question of debate IOP is affected by various systemic and local factors. The normal range of IOP is between 10 and 20 mm of Hg. The normal IOP is determined by the balance of production of aqueous humor and its drainage through the trabecular meshwork. Any imbalance in production and drainage leads to rise in IOP.[10] Glaucoma is a disease condition characterized by chronic progressive optic neuropathy and typical visual field changes. Elevated IOP is the major risk factor for glaucoma.

The fact that diabetes can affect the IOP is less known. IOP measurement is usually neglected in the regular ocular screening of diabetic patients. The mainstay in the prevention of blindness due to glaucoma is early detection and intervention. We conducted this study to find answers to our question that whether diabetes mellitus is a risk factor for raised IOP? IOP is affected by blood sugar levels? and whether the poor glycemic control is a risk factor for raised IOP or not?

MATERIALS AND METHODS

The current study was an observational, cross-sectional study. The Institutional Ethics Committee and Institutional Research Committee Clearance were procured. Total 180 participants were included in the study. Written consent was obtained from all the participants. The participants were divided into two groups. Group I included 80 age- and sex-matched normal healthy non-diabetic participants constituting the control group. Group II consisted of 100 diabetic patients. Group II was further subdivided into 3 subgroups based on glycemic control: Group IIA consisted of 36 patients with hemoglobin A1c (HbA1C) levels <7% indicating good glycemic control, Group IIB consisted of 34 patients with HbA1C levels between 7% and 8% indicating fair diabetic control, and Group IIC consisted of 30 patients with HbA1C levels >8% indicating poor diabetic control. IOP recording was done after overnight fasting and 2 h after meal (postprandial) of all the participants. The participants underwent routine general physical examination including the vitals and anthropometric parameters. They were investigated for HbA1C, fasting, and postprandial blood sugar levels. The patients underwent anterior segment examination under slit lamp, ophthalmoscopy, and IOP measurement by Goldmann applanation tonometry. The statistical comparison was made using SPSS version 18.5 between the groups and in fasting and postprandial state in all the participants. Student's *t*-test was used to compare the IOP in diabetic and non-diabetic patients. Furthermore, the Student's *t*-test was used to compare the IOP in fasting and postprandial state. The $P < 0.005$ was considered significant. To compare the IOP between Groups I, IIA, IIB, and IIC ANOVA test was used. The $P < 0.005$ was considered significant.

RESULTS

The mean IOP of the non-diabetic participants was 14.56 ± 0.23 and the mean IOP of the diabetic patients was 17.71 ± 0.11 ($P < 0.005$) (Table 1). The mean IOP of Diabetic subjects with HBA1C<7% was 16.9±0.43 mm Hg with HBA1C 7-8% was 17.6±0.62 mm of Hg and with HBA1C>8% was 18.62±0.22 mm of Hg ($P<0.005$) (Table 2). The mean IOP of all the participants in fasting state was 15.67 ± 1.34, and the mean IOP of all the participants in postprandial state was 16.89 ± 0.67 ($P < 0.005$) (Table 3). The postprandial IOP was higher than IOP in fasting state in both diabetic and non-diabetic participants.

DISCUSSION

In our study, we found a higher IOP in diabetic group as compared to the non-diabetic age- and sex-matched control group. The difference was statistically significant ($P < 0.005$). The literature search suggests similar findings by various researchers in the past. Baltimore eye survey found an association between raised IOP and diabetes mellitus.[8] Zhao et al. in their study recognized diabetes and duration of diabetes as a significant risk factor for glaucoma.[11] Diabetes as a risk factor for glaucoma has been recognized by multiple investigators from different ethnic groups.[12-15] The exact mechanism how diabetes mellitus leads to raised IOP is not known. Higher glucose levels in the aqueous of patients with diabetes mellitus have been observed by the previous investigators. The levels of glucose are found to be 2-3 times higher in diabetic patients as compared to non-diabetic participants.[16] Aqueous flows through the trabecular meshwork hence remain in constant contact with

Table 1: Comparison of IOP among diabetic and non-diabetic participants

Parameter	Non-diabetic (Group I)	Diabetic (Group II)	*P* value
Total number	80	100	
Mean IOP±SD	14.56±0.23	17.71±0.11	0.0021**

***P*<0.005 considered significant. SD: Standard deviation, IOP: Intraocular pressure

Table 2: Comparison of IOP among the groups according to glycemic control

Parameter	Non-diabetic (Group I)	Good glycemic control (Group IIA)	Fair glycemic control (Group IIB)	Poor glycemic control (Group IIC)
Total number	80	36	34	30
Mean±SD HBA1C	4.45±0.45	6.23±0.24	7.46±0.89	9.94±0.56
Mean±SD IOP	14.56±0.23	16.9±0.43	17.60±0.62	18.62±0.22

**P<0.001, *P*<0.005 difference was statistically significant. Statistical analysis was done using ANOVA test. SD: Standard deviation, IOP: Intraocular pressure

Table 3: Comparison of IOP of all participants in fasting and postprandial state

Parameter	Fasting	Postprandial	*P* value
Mean IOP±SD	15.67±1.34	16.89±0.67	0.0032**

P<0.005 **Considered significant. SD: Standard deviation, IOP: Intraocular pressure

it. The possible suggested mechanisms based on experimental studies using *in vitro* cell culture method are glucose-induced upregulation of fibronectin.Increased fibronectin accumulation in the extracellular matrix of trabecular meshwork blocks the aqueous outflow facility. Decreased aqueous drainage leads to rise in IOP. Raised IOP, in turn, leads to progressive damage of optic nerve head and retinal ganglion cells due to mechanical compression.[17]

In our study, we also observed that the diabetic patients with higher levels of HBA1C have higher IOP than patients with lower HBA1C levels. Our findings indicate an association between hyperglycemia and raised IOP and indicate poor glycemic control as a risk factor for glaucoma in diabetic patients. The findings of our study were in accordance with the study done by Anandha et al. on the South Indian population.[18] Rotterdam study and Framington study also suggest hyperglycemia as a risk factor for raised IOP. Diabetic patients with tight diabetic control demonstrate lower IOP.[19,20]

We also documented a higher IOP in the postprandial state as compared to fasting state indicating a positive association between blood glucose level and IOP. Pimentel et al. in their study found similar findings, i.e. high IOP in the postprandial state than in fasting state. Overall our findings were consistent with the existing reports in the literature.[21] Zhao et al. also documented a significantly higher IOP in diabetic patients with higher fasting blood glucose levels.[11] Hymowitz et al. also noted a higher IOP in patients with poor glycemic control. Findings from various studies in the literature suggest poor glycemic control and hyperglycemia as a risk factor for glaucoma.[22]

To explain the association of raised IOP with diabetes mellitus, various explanations have been put forward. Osmotic gradient created by raised blood level have been documented as a cause of increased fluid in intraocular space.[13] Some associate it to genetic factors[23] while others consider autonomic dysfunction being responsible for it.[24] Diabetes is also known the cause of microvascular damage hence can disturb microcirculation at the level of optic nerve head and retinal blood flow which leads to glaucomatous optic neuropathy besides raised IOP.[25] Collective evidence from various studies and result of the current study, it is reasonable to consider poor glycemic control and raise blood glucose levels in diabetes mellitus a risk factor for raise IOP and glaucoma.

Limitation

A longitudinal study is needed to see the trend of IOP with the progression of disease in diabetic patients .Expansion of the study to see the effect of blood glucose levels and HBA1C on IOP in Type I diabetes mellitus patients is also needed.

CONCLUSION

We concluded that diabetes mellitus is a risk factor for raised IOP. Tight glycemic control prevents the rise in IOP. Patients with poor glycemic control were found to be more prone to raised IOP. Diabetic patients should be regularly screened for IOP so that burden ocular morbidity due to glaucoma can be reduced.

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