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Research Article

A COMPARATIVE STUDY OF INTRAOCULAR PRESSURE AND BLOOD SUGAR LEVEL IN THE POPULATION OF WESTERN INDIA

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A B S T R A C T

The aim of this study was to assess the relationship between Diabetes mellitus and Glaucoma by checking the association between blood sugar levels (BSL) and corresponding intraocular pressure (IOP) in diabetic and non-diabetic patients. Eighty-two non-diabetic and Seventy-one diabetic subjects were part of the study. The subjects underwent complete ocular examination. IOP using applanation tonometry, at Fasting and postprandial was recorded. BSL at Fasting and Postprandial was measured by Glucose oxidase/Peroxidase method. Postprandial IOP was significantly higher than baseline IOP in diabetic (18.01 ± 3.55 versus 15.07 ± 3.23 mmHg; $p < 0.001$) and non-diabetic patients (14.58 ± 3.31 versus 12.06 ± 2.50 mmHg; $p < 0.001$). Postprandial BSL were significantly higher than baseline measurements in both diabetic (mean increase of 79.18 mg/dL; $p < 0.001$) and non-diabetic patients (mean increase of 20.48 mg/dL; $p < 0.001$). Correlative analysis showed a very statistically significant association between post-prandial BSL and post-prandial IOP in diabetic subjects with Pearson's coefficient at 0.3728 ($p<0.0001$). For non-diabetic patients. Correlative analysis showed a lesser significant correlation with Pearson's coefficient at 0.1739 ($p<0.05$). We concluded that there is a significant association between BSL and IOP variation, especially in diabetic patients.

INTRODUCTION

Primary Open Angle Glaucoma (POAG) is a chronic, progressive optic neuropathy characterised by morphological changes at the optic nerve head and retinal nerve fibre layer in the absence of other ocular disease or congenital anomalies [with / without a raised intraocular pressure (IOP)] [1] .

It is the third leading cause of preventable blindness in India [2]. Glaucoma can remain asymptomatic until a severe stage, resulting in a high prevalence of undiagnosed glaucoma worldwide [3]. Although glaucoma is a multifactorial disease, elevated IOP remains its major known risk factor [4,5] . Studies have demonstrated a significant role of IOP in progression of glaucoma [6,7] . IOP can be influenced by different systemic factors such as hypertension [8-10], atherosclerotic diseases [8], body mass index [11], and diabetes [8,12,13] .

There is increasing global prevalence of diabetes. International Diabetes Federation estimated that there were 382 million people with diabetes in 2013, surpassing its previous predictions. More than 60% of the people with diabetes live in Asia.

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India alone has a burden of 65.1 million people with diabetes, occupying the second position next to China in IDF global list of top 10 countries for people with diabetes [14] . There is high prevalence of pre diabetes in Indian population with a more rapid progression to diabetes[15]

Studies suggest that diabetes may influence risk of Primary Open Angle Glaucoma (POAG) via hyperglycaemia-related vascular constriction leading to elevated intraocular pressure [16,17] and increased susceptibility to glaucomatous optic nerve damage [18]. According to Sato and Roy, high glucose levels in the aqueous humor of patients with diabetes may increase fibronectin synthesis and accumulation in the trabecular meshwork. The accelerated depletion of trabecular meshwork cells is a characteristic feature of the outflow system in POAG [19]. Pasquale et al. noted the correlation between glycosylated haemoglobin and increased ocular pressure [20,21,22] and speculated that glycosylation of extracellular matrix proteins in the trabecular meshwork could further reduce outflow facility in patients with type 2 diabetes [21]. Therefore, relative obstruction of the outflow of aqueous humor via the trabecular meshwork may be a primary mechanism by which diabetes affects POAG risk.

With increasing burden of diabetes and glaucoma in India, this study was undertaken to determine the relationship between glucose level variation and IOP fluctuation in diabetic and non-diabetic patients. Our study demonstrates the need for

ophthalmic evaluation in consideration with blood glucose fluctuation, in diabetic individuals. It can be developed as a tool for monitoring and recording disease progression.

METHODOLOGY

It was a prospective observational study design. To make a better evaluation, diabetic and nondiabetic (healthy) volunteers were compared. An ethical approval from Institutional Ethics committee was taken before starting the study. All participants were given complete information of the study and a written informed consent was taken.

Patients were enrolled in the study after applying the inclusion and exclusion criteria. Healthy subjects were recruited from the general population or from spouses and relatives of diabetic patients.

Inclusion criteria

Patients of age ≥ 18 years.
Patients fulfilling Who Criteria for Diagnosis of Diabetes Mellitus:

- Fasting plasma glucose ≥ 126mg/dL
- HbA1C ≥ 6.5%
- Two-hour plasma glucose ≥ 200mg/dL during an oral glucose tolerance test

Exclusion criteria

- Recent ocular surgery within last 6 months
- Secondary glaucoma
- Medications that would affect the Intraocular pressure (Steroids, antidepressants)
- History of endocrinal diseases.

All diabetic patients included in the study were on medication throughout the study period.

A detailed history followed by ocular examination including visual acuity, central corneal thickness, and visual field using automated perimetry was taken. Intraocular pressure (IOP) using applanation tonometry, at Fasting and post prandial was recorded. Blood sugar level at Fasting and Post prandial was measured by Glucose oxidase/ Peroxidase method (GOD/POD)

Statistical analysis was done using Student's t test and Pearson's correlation coefficient.

OBSERVATIONS AND RESULTS

A total of 153 patients (82 non-diabetic and 71 diabetic) were included. There were 94 female and 59 male patients in the study. Out of females 35 were diabetic and out of male 36 were diabetic.

Selected characteristics of the study are shown in Table 1. Postprandial IOP was significantly higher than baseline IOP in diabetic and non-diabetic patients. Postprandial glucose levels were significantly higher than baseline measurements in both diabetic and non-diabetic patients.

Correlation between BSL and IOP was done using Pearson's Test. Correlative analysis showed a very statistically significant association between post-prandial blood sugar levels and post-prandial IOP in diabetic subjects. For non-diabetic patients correlative analysis did not show statistically significant association. This is shown in Table 2 and the scatter diagram is shown in Fig 1.

The correlation between post-prandial BSL and post-prandial IOP were marginally higher in females compared to males. This is shown in Table 3 and the scatter diagram in shown in Fig 2.

Table 1 Comparison of variables between Diabetics and Non-diabetics

Variable	Diabetic (n=71) Mean ± SD	Non-Diabetic (n=82) Mean ± SD	p Value
BSL Fasting	128.77 ± 52.15	88.95 ± 9.95	p < 0.001
IOP (mmHg) Fasting (Right Eye)	15.07 ± 3.23	12.06 ± 2.50	p < 0.001
IOP (mmHg) Fasting (Left Eye)	15.79 ± 3.43	12.69 ± 2.53	p < 0.001
BSL PP	207.95 ± 83.40	109.43 ± 17.09	p < 0.001
IOP (mmHg) PP (Right Eye)	18.01 ± 3.55	14.58 ± 3.31	p < 0.001
IOP (mmHg) PP (Left Eye)	18.60 ± 3.72	14.98 ± 3.22	p < 0.001

Table 2 Correlation between BSL and IOP in diabetics and non-diabetics

Variable	Diabetic (n=71)		Non-Diabetic (n=82)	
	Fasting	Post Prandial	Fasting	Post Prandial
Pearson's coefficient Right Eye	0.1780	0.3728	-0.0507	0.1739
Pearson's coefficient Left Eye	0.1499	0.3801	0.0702	0.1759
p Value	p < 0.001	p < 0.001	p < 0.05	p < 0.05

Table 3 Correlation between BSL and IOP in Females and Males

Variable	Females (n=94)		Males (n=59)	
	Fasting	Post Prandial	Fasting	Post Prandial
Pearson's coefficient Right Eye	0.2590	0.4825	0.3905	0.4658
Pearson's coefficient Left Eye	0.2610	0.4905	0.3985	0.4718
p Value	p < 0.001	p < 0.001	p < 0.001	p < 0.001

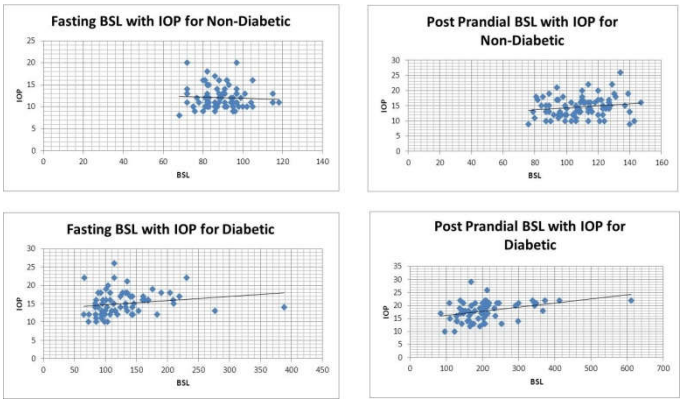

Fig 1 Scatter Diagram and Correlation between BSL and IOP for Diabetic and Non-Diabetic

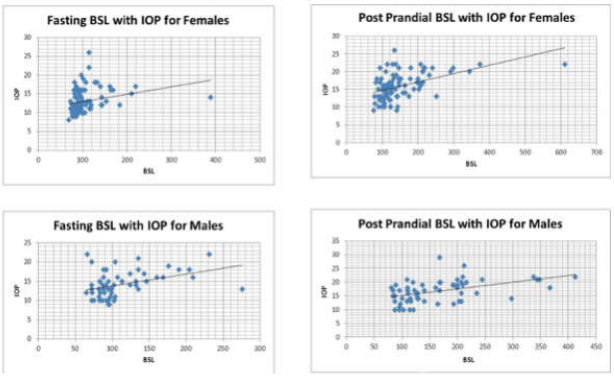

Fig 2 Scatter Diagram and Correlation between BSL and IOP for Females and Males

DISCUSSION:

Although several risk factors for the development of POAG have been evaluated, this is a field of ongoing investigation [23]. Diabetes has been positively correlated with glaucoma in many previous studies [13,20,24-26] .

Several hypotheses have been established to explain the association between high glucose levels and IOP. Some researchers are of opinion that a diabetic person may have an autonomic dysfunction which would lead to an IOP increase [27].

However, some authors believe that elevated blood glucose results in the induction of an osmotic gradient which leads to fluid shifts into the intraocular space [28].

Anadhi et al correlated glycosylated haemoglobinA1c (HbA1c) levels and IOP [25]. Their study concluded an increase in IOP in diabetic as compared to controls. Our study results are in agreement with their results. Postprandial IOP was significantly higher than baseline IOP in diabetic (mean IOP 18.01 versus 15.07 mmHg for right eye and 18.60 versus 15.79mmHg for left eye). For ease of measurement in mass population, their study used Schtioz tonometry for IOP measurement. In our study we used applanation tonometry to measure IOP which is a GOLD standard.

Another study by Luis Guilherme et al [26] determined a significant correlation in fasting as well as post prandial variation among diabetics and non-diabetics. Our findings are consistent with this study. Their study used peripheral glucose testing to determine blood glucose levels while our study used venous blood sampling. In our study we found a significant positive correlation of glucose variation and IOP in diabetics and non-diabetic individuals. The Pearson's coefficient for fasting blood sugar levels and fasting IOP was 0.3218 ($p<0.0001$) for Right Eye and 0.3161 ($p<0.0001$) for Left Eye. The Pearson's coefficient for post-prandial blood sugar levels and post-prandial IOP was 0.4820 ($p<0.0001$) for the Right Eye and 0.4659 ($p<0.0001$) for the Left Eye.

In the Blue Mountain Eye Study [13], the authors attempted to study the relationship between diabetes and open-angle glaucoma and found that glaucoma prevalence was higher in diabetic patients compared to those without diabetes (5.5% versus 2.8%, OR = 2.12). Though our study does not determine the prevalence of glaucoma, it indirectly corroborates the results.

This correlation between diabetes mellitus and intraocular pressure would enable a thorough ocular examination of diabetic patients resulting in prompt and timely management of glaucoma and reducing its complications.

It would also promote the development of guidelines for better management of diabetic patients. To help to prescribe timings for anti glaucoma medications, it is important to consider the IOP variation in accordance with glycemic control and provide management accordingly.

We believe that further studies should be done to evaluate the causative relationship between glucose levels and IOP variation as the IOP variation could have been affected by different factors other than glucose levels. Therefore, longitudinal studies should help us to better understand the connection between these two variations. Furthermore, another relevant factor that could be addressed in future studies is the corneal hysteresis that could be measured by Ocular Response Analyzer (Reichert Ophthalmic Instruments, Depew, NY, USA). Different studies have reported that corneal hysteresis is affected by HbA1c, intraocular pressure, and central corneal thickness.

CONCLUSION

Our study shows a significant positive correlation between blood glucose variation and IOP among diabetics and non-diabetics.

The post prandial glucose levels were also found to be significantly higher compared to baseline. The study also demonstrates a need for assessment of anti-glaucoma medication efficacy in relation with glycemic control of patients.

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