Original article:

Comparison of Intraocular pressure and Body Mass Index in Diabetic and Non -diabetic individuals: A Pilot Study

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ABSTRACT:

Introduction: Intraocular pressure constitutes the most important risk factor for the emergence of glaucoma which is most often associated with systemic arterial hypertension and diabetes mellitus. Diabetes mellitus is an important ocular risk factor with the occurrence of retinopathy, certain types of lens opacification (cataract), intraocular pressure increase and also, open angle glaucoma during its course .The main objective of this study is to compare the Body Mass Index (BMI) and Intra Ocular Pressure (IOP) in normal subjects and subjects with diabetes.

Materials & Methods: 74 subjects, aged between 40-70 years, out of which 26 were diabetics and 28 non-diabetics (control group) and also , 20 subjects with both diabetes and hypertension were included in our study after obtaining their consent .

Observation: The mean IOP in diabetic group in Right and Left eyes showed an increase in IOP of 0.8 and 1.3 mm Hg when compared with the non-diabetic (control) group. Also, the mean Body Mass Index (BMI) in diabetic group showed 0.8 kg/m^2 increase when compared with non diabetic subjects.

Results & Conclusion : With this study, we conclude that the mean IOP in diabetic subjects showed a marginal increase when compared with non diabetic subjects . When BMI was evaluated, it was found that the mean BMI in diabetics was 26.4 kg/m^2 and the mean BMI was 25.6 kg/m^2 in non -diabetics. Body mass index, a measure of obesity, appears to be positively correlated with IOP in diabetic and both diabetic ,hypertensive subjects.

Keywords : Intraocular Pressure, Body Mass Index , Glaucoma, Diabetes, Hypertension

INTRODUCTION: Elevated intraocular pressure, which is a main risk factor for glaucoma, is a major concern among diabetics. IOP (Intraocular pressure) has been associated with different systemic, familial, anthropometric and demographic factors by several studies [(1)] . Diabetes is one of the world's greatest health challenges. India is already a world leader, with over 35 million people with diabetes - a number that is predicted to increase to around 80 million by 2030. Diabetes mellitus is an important ocular risk factor [(2)]. People with diabetes are more likely to become legally blind than those without diabetes.

Diabetes as a pre-existing condition increases the risk of glaucoma, the second leading cause of visual impairment and blindness. Several studies have reported factors including age, sex, African ancestry, blood pressure, BMI, alcohol, smoking, myopia and family history of glaucoma to be positively associated with elevated IOP in general [(3)]. Currently glaucoma is defined as disturbance in structural or functional integrity of optic nerve leading to visual field defects over a period of time. The development of optic nerve damage leading to visual field loss / or optic disc findings, is more likely

to be associated with high intraocular pressure, although IOP is not the only risk factor for glaucomatous nerve damage.

Diabetes mellitus cause micro vascular damage and also affect vascular auto- regulation in the retina and optic nerve. Diabetes has been found to be associated with elevated intraocular pressure (IOP), particularly primary open angle glaucoma (POAG). There have been several hypotheses for the association between diabetes and elevated IOP. Diabetes - related autonomic dysfunction might be the probable factor which contributes to an increase in IOP [(4)].

Glycation - induced corneal collagen cross-links in diabetes can cause corneal stiffening, which also increases the level of measured IOP over the true IOP [(5)]. Corneal hysteresis has also been shown to have an effect on glaucoma risk independent of corneal thickness [(6)]. Excess intraorbital fat tissue, increased episcleral venous pressure, and increased blood viscosity with increased outflow resistance of episcleral veins explain the association between increased BMI and IOP.

Obesity increases blood viscosity through increasing red cell count, hemoglobin and hematocrit and consequently, increased outflow resistance of episcleral veins occur. Further, obesity is also a risk factor for hypertension. Elevated BP increases IOP by increasing ciliary artery pressure and ultrafiltration of aqueous humor. The main objective of this study was to compare the BMI and IOP in normal subjects and subjects with diabetes (type 2 diabetes) between 40-70 years age**.** The implications of this study is to highlight the strong positive association between BMI and IOP in diabetics.

MATERIALS & METHODS : 74 subjects, aged between 40-70 years out of which 26 were diabetics and 28 nondiabetics (control group) and also , 20 subjects with both diabetes and hypertension were included in our study after obtaining their consent . An approval was obtained from Institutional Ethical committee. Hypertensive's, known diabetics undergoing treatment; glaucoma or IOP lowering medications, ocular diseases; H/O of current smoking or alcohol use were excluded. IOP was measured in both eyes using Schiotz tonometer and recorded. Subjects height in metre's ,weight in kg was recorded . BMI is calculated as weight (kg) / height (in $m)^2$. Blood glucose was estimated using Glucometer. Subjects were considered diabetics when fasting glucose was > 120mg/dl or [post prandial blood glucose > 150mg / dl] . IOP measurements were always performed between 9:00 am-12:00 pm by Schiotz tonometry, as to minimize the diurnal variation.

Statistical analysis: All the results were shown as Mean ± SD . The results were evaluated using student t test, two sample assuming unequal variances . P value < 0.05 was considered statistically significant. Statistical analysis was performed using Graph pad software .

OBSERVATION & RESULTS:

Table 1: Comparision of IOP & BMI in Non-Diabetic , Diabetic and Diabetic hypertensive individuals

	Control Group (Non Diabetic)	Diabetic Group	Diabetic Hypertensive Group
Body Mass Index (Mean ± SD) (BMI – Kg/m^2)	25.6 ±3.8	26.4 ± 4.2	28.3 ± 3.2
Mean IntraOcularPressure (mmHg) (Right) → (Left) →	15.0 ± 3.8 16.2 ± 3.3	15.8 ± 2.7 17.5 ± 4.0	15.3 ± 3.1 17.6 ± 3.8
Mean Random Blood Sugar (mg %)	91.1±15.2	198 ± 75	160 ± 43.6

Table 2 : Comparison of t & p values between different groups

	ND/D	ND/DH	D/DH
BMI	t=0.68 p= 0.5	t =2.69 p=0.01	t =1.8 p=0.08
IOP (RIGHT)	t=0.86 p= 0.39	t =0.24 p=0.81	t =0.60 p=0.54
IOP (LEFT)	t=1.33 p= 0.11	t =1.38 p=0.18	t =0.10 p=0.92

ND – Non Diabetic group **D – Diabetic** **DH – Diabetic Hypertensive**

In our study , the mean BMI in the non diabetic subjects is 25.6 ± 3.8 Kg/m^2 , the mean IOP in the Right and Left eyes in these non-diabetic subjects is 15.0 ± 3.8 and 16.2 ± 3.3 mmHg respectively. The Random Blood sugar in these subjects is 91.1 ± 15.2 mg%.

The mean BMI in the diabetic subjects is 26.4 ± 4.2 Kg/m^2; the mean IOP in the Right and Left eyes in these diabetic subjects is 15.8 ± 2.7 and 17.5 ± 4.0 mmHg respectively. The Random Blood sugar in these subjects is 198 ± 75 mg%.

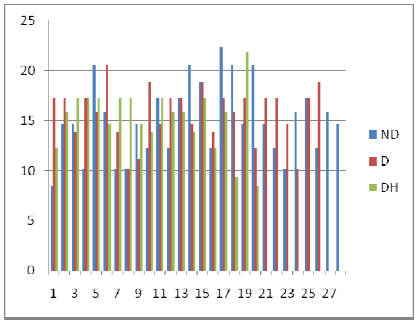
The mean BMI in the diabetic and hypertensive subjects is 28.3 ± 3.2 Kg/m^2 , the mean IOP in the Right and Left eyes in these diabetic hypertensive subjects is 15.3± 3.1 and 17.6 ± 3.8 mmHg respectively. The Random Blood sugar in these subjects is 160 ± 43.6 mg%.

Daibetics show higher IOP than non diabetics. The mean IOP in general population (i.e. non diabetics) was 15.0 ± 3.8 and 16.2 ± 3.3 mmHg in right and left eyes respectively. The normal mean IOP reported by Becker (10) was 16 .1mmHg.

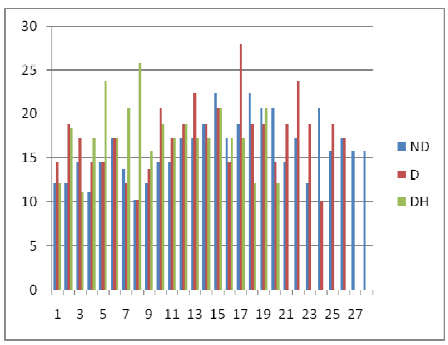
The mean IOP in diabetics from our study was 15.8 ± 2.7 and 17.5 ± 4.0 mmHg in right and left eyes respectively. A marginal increase in mean IOP in diabetics was found in our study .However our study is not in agreement with the report of Palomar [7] and Armaly [8] who observed low IOP in diabetics as compared to non diabetics.

When BMI was evaluated , the mean BMI in the diabetics subject from our study is 26.4 ± 4.2kg/m^2 and the mean BMI in the non diabetic subjects was 25.6 ± 3.8kg/m^2. A trend of increasing IOP with increasing BMI was observed in diabetics. The results of our study were in accordance the results of Barbados eye study, Shiose et al [9] , Klien et al [10] and Bulpitt et al [11].

Graph -1 showing IOP variation in Right eye in Non - diabetic, Diabetic & Diabetic Hypertensives



Graph-2 showing IOP variation in Left eye in Non - diabetic, Diabetic & Diabetic Hypertensives



DISCUSSION :

The results of the "Barbados Eye Study" [12] showed that IOP increase is related to systemic arterial blood pressure. In addition, it reports a relationship between IOP increase and diabetes mellitus, a fact that supports the "The Blue Mountains Eye Study" [13] and the "Baltimore Eye Survey" [14] .

Sujatha Chandrasekaran, Robert G. Cumming, Elena Rochtchina,, MapplStat, Paul Mitchell et al [13] examined incident relationships between elevated intraocular pressure (IOP), open-angle glaucoma (OAG), and use of glaucoma medications with 5-year incident cataract (The Blue Mountains Eye Study). Age- and gender-adjusted analyses showed similar but statistically significant associations. The association between elevated IOP or Ocular Hysteresis and nuclear cataract was significant in multivariate analyses . Barbara E. K. Klein, Ronald Klein, and Karhryn L. P. Linton et al conducted the Beaver Dam Eye Study [15] and they found an association of IOP with systolic and diastolic blood pressures, body mass index, hematocrit, serum glucose, glycohemoglobin, cholesterol level, nuclear sclerosis, season, and time of day of measurement. Body mass index, a measure of obesity, was correlated positively with IOP. Gavin S. Tan, Tien Y. Wong ; Chee-Weng Fong; Tin Aung et al [16] examined the relationship of diabetes mellitus and metabolic abnormalities with intraocular pressure and glaucoma. After controlling for age, sex, education, smoking, central corneal thickness, and diabetes treatment, intraocular pressure was higher in persons with, than without diabetes (16.7 vs 15.0mmHg) and in those with higher serum glucose levels, glycosylated hemoglobin concentrations , total cholesterol levels , triglyceride levels, and body mass index .

Sheila Pai, Shobha Pai, Ashwin Pai, Ramasamy C, Rekha D Kini et al [17] conducted a Correlative Study of BMI and IOP in Diabetic and Non-diabetic South Indian Population. They observed that the diabetics have higher IOP and higher BMI. The BMI is associated with increased IOP in subjects with diabetes. Newly diagnosed diabetes mellitus and high levels of blood glucose are associated with elevated IOP and high-tension glaucoma. Ivan Goldberg, Franco francs et al [18] studied about the relationship between Intraocular Pressure and Preservation of Visual Field in Glaucoma. Intraocular pressure correlates with progressive loss of visual field in patients with glaucoma. Decreasing IOP has been proven to reduce progressive loss of the visual field. L Xu, XW Xie, YX Wangand ,JB Jonas et al [19] conducted studies to assess ocular and systemic factors associated with diabetes mellitus in the adult population in rural and urban China. The presence of diabetes mellitus was significantly associated with body mass index, systolic blood pressure, triglyceride concentrations, intraocular pressure, presence of arteriolar sheathing, rural vs urban region, lower best-corrected visual acuity, lower high density lipoprotein level, and lower diastolic blood pressure. Mieko Hayashi, Michael E Yablonski, Cynthia Boxrud, Nora Fong, Cherl Berger and Lois J Jovanovic et al [20] studied about the rate of aqueous humour formation. The rate of aqueous humour formation was measured by fluorophotometry. Intraocular pressure, age, duration of diabetes, haemoglobin Alc, and blood glucose levels had no significant effect on aqueous flow in diabetic patients. The diabetic eye suffers from ischaemia because of a variety of circulatory abnormalities in diabetics , including a generalised angiopathy, an increased blood viscosity and impaired oxygen release by the red blood cells due to decreased 2,3-diphosphoglycerate (2,3-DPG) and increased glycosylated haemoglobin. Robert David , Linda Zangwill, Davidstone and Yuval Yassur et al [21] evaluated the association between intraocular pressure and various socio-demographic characteristics, ocular findings, and cardiovascular risk factors in a population screened for glaucoma. The mean IOP increased with age, was higher among persons born in Africa or Asia than those born in Europe or America, higher among myopes than hypermetropes and among those with an enlarged cup-disc ratio (CDR). Analysis of variance tests indicated that refractive status, CDR, age, country of birth, and diabetes were each independently associated with IOP.

CONCLUSION :

The mean IOP in diabetic group in Right and Left eyes showed an increase in IOP of 0.8 and 1.3 mm Hg when compared with the non-diabetic (control) group. Also, the mean BMI in diabetic group showed 0.8 kg/m^2 increase when compared with non diabetic subjects. The mean random blood sugar levels in diabetic group is 198 mg% and the random blood sugar levels in non- diabetic subjects is 91.1 mg%.

The mean IOP in diabetic hypertensive group in Right and Left eyes showed a slight increase in IOP of 0.3and 1.4 mm Hg when compared with the non-diabetic (control) group. Also, the mean BMI in diabetic hypertensive group showed 2.7 kg/m^2 increase when compared with non diabetic subjects. The mean random blood sugar levels in diabetic hypertensive group is 160 mg% and the random blood sugar levels in non- diabetic subjects is 91.1mg%.

With this study, we might conclude that the mean IOP in diabetic subjects showed a marginal

increase when compared with non diabetic subjects, which is not statistically significant (Right eye - t value 0.86, p value 0.39 – Left eye t = 1.33, p = 0.11). When BMI was evaluated, it was found that the mean BMI in diabetics was 26.4 and the mean BMI was 25.6 in non-diabetics. The BMI was higher in diabetics than those without diabetes which was not statistically significant (t value 0.68, p value 0.5).

Also the mean IOP in diabetic hypertensive subjects showed an increase when compared with non diabetic subjects. Body mass index, a measure of obesity, appears to be positively correlated with IOP in diabetic and both diabetic hypertensive subjects. Although some cross-sectional studies reported an association between elevated IOP and diabetes or high GHb levels, others did not. Our results showed a higher IOP in persons with a diabetes history.

Our study showed a significantly higher IOP in diabetics than the non-diabetics. Increase in BMI appears to be a positive additive determinant of raised IOP in diabetics. Excess weight is one of the most important risk factors for elevated IOP in diabetics. Weight control is the most natural primary intervention method in the inter-relation of obesity, diabetes and elevated IOP and in the prevention of subsequent development of POAG in diabetics.

Limitations: The results of our study did not show a significant p value as the sample size is small. Further cross- sectional studies with large sample size can be recommended to elucidate significant statistical relation between IOP and Diabetes .

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Conflicts of Interest: None

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