

Relationship between Body Mass Index and Intraocular Pressure in Diabetic and Hypertensive Adults

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Purpose: To Evaluate the relationship between body mass index and intraocular pressure in Diabetic and Hypertensive adults presenting to the Out Patient department of Dow International Medical College.

Study Design: Descriptive Cross – sectional study.

Place and Duration of Study: Department of Ophthalmology, Dow University Hospital (Ojha Campus) of Dow International Medical College, Dow University of Health Sciences, Karachi, Pakistan from 15 March 2015 to 15 April 2015.

Material and Methods: This study done in the Department of Ophthalmology, Dow University Hospital (Ojha campus) of Dow International Medical College, Dow University of health sciences, Karachi, Pakistan from 15 March 2015 to 15 April 2015. 101 patients were Included in the study group who were known Diabetics with or without Hypertension. Height, weight, blood pressure and intraocular pressure (IOP) were recorded in these patients. IOP was measured using the Goldmann applanation tonometer. The correlation between Body Mass Index (BMI) and IOP was calculated and the statistical analysis was done by SPSS version 21.

Results: 101 patients were examined, 45 were males and 56 were females. Mean BMI was 29.86 ± 5.87 in patients having diabetes with hypertension and 27.49 ± 4.99 in only diabetic patients. The mean IOP was found to be 16.34 ± 0.34 in diabetic and hypertensive patients and 15.98 ± 0.43 in diabetic patients. BMI was significantly correlated with IOP in both diabetic with or without hypertensive adults.

Conclusion: These results show a correlation between BMI and IOP in both diabetic patients with or without hypertension. Increase in BMI is strongly associated with increase in IOP.

Key words: Body Mass Index, Diabetes, Hypertension, Intraocular Pressure, Glaucoma.

Intraocular pressure (IOP) is pressure within the eye ball and is determined by production, circulation and drainage of ocular aqueous humor. Parameters involved in the maintenance of intraocular pressure are aqueous flow, outflow facility, uveoscleral out flow and episcleral venous pressure. Increase in IOP associated with glaucomatous optic nerve damage and leads to subsequent detonation in

vision.^{1,2} IOP is currently the only modifiable risk factor for glaucoma.³ IOP has been associated with different systemic, familial, anthropometric and demographic factors by several studies⁴. Several epidemiological studies have shown an association between obesity and IOP in adults.^{5,6}

Obesity is one of the most prevalent disorders of the world. It is an important risk factor for several

diseases like hypertension, diabetes, stroke etc. Obesity increases blood viscosity through increasing red cell count, hemoglobin and hematocrit and consequently, increased outflow resistance of episcleral veins occur. IOP is high in Diabetics as compared to non-diabetics and an increase in IOP is seen to be associated with increasing Body mass index (BMI) and there is a positive correlation between BMI and IOP in diabetics.⁷

Hypertension is defined as systolic blood pressure (SBP) ≥ 140 mm Hg or diastolic blood pressure (DBP) ≥ 90 mm Hg and has an increased prevalence in individuals with a body mass index (BMI) of overweight (BMI 25.0 - 29.9) or obese (BMI ≥ 30).⁸

To explain the relationship between blood pressure (BP) and IOP there are two theories that have been proposed.⁹ The first theory states that the autonomic nervous system, which is mainly involved in the regulation of BP, may affect the circadian rhythm of aqueous mainly involved in the regulation of BP, may affect the circadian rhythm of aqueous humor secretion, which would then result in corresponding changes in IOP¹⁰. The second theory states that angiotensin converting enzyme (ACE) may bring about changes in IOP as it is involved in the renin angiotensin system by mechanisms such as blocking the action of cholinesterase or by up regulating prostaglandin production.¹¹ Glaucoma and Diabetes Mellitus (DM) are seen to run in families and the first degree relatives are at higher risk of acquiring the disease. Also Glaucoma is often symptomless and goes undetected until patients start to experience significant decrease in vision and difficulty with their daily activities. Obesity is one of the other risk factor for both IOP and other systemic vascular abnormalities such as hypertension and arteriosclerosis. In this study we aim to analyse the effect of BMI on elevation of intraocular pressure in diagnosed diabetic patients with or without associated hypertension.

MATERIAL AND METHODS

This study was conducted over a one month period in the Ophthalmology department of Dow International Medical College, Karachi Pakistan. A total of 101 patients were analyzed after obtaining an informed consent. 57 subjects were diabetics with associated hypertension while 44 subjects were those without hypertension. Individuals that were aged 20 - 70 years, both genders, having diabetes alone or with

hypertension were included in the study. Candidates that were taking any IOP lowering agent, active eye infection, recent eye surgery and patients using steroids in any form were excluded from the study. The subjects went through detailed examination in which there was measurement of blood pressure, measurement of height, tonometry and ocular examination including funduscopy. Measurement of IOP in both eyes was done with a Goldmann applanation tonometer. IOP measurements were always performed between 9:00 am - 12:00 pm by Goldmann tonometer so as to reduce the diurnal variation bias. Subject's height was measured using a standard scale, weight using a standard weighing machine, blood pressure using a sphygmomanometer and pulse rate. BMI was calculated as weight in kilogram/height in metre.^{2,12} we reported frequencies and percentages for categorical variables and reported mean and standard deviation (SD) for continuous variables. We performed non parametric tests to find the association between means. Associations between two independent means were calculated by using the Mann - Whitney test and the associations between more than two independent means were calculated by using the Kruskal - Wallis test. We used SPSS version 21 for data analysis, and p-value ≤ 0.05 was taken as significant level.

RESULTS

The subjects were divided into two groups. One group had diabetes with hypertension while the other group was diabetic without hypertension. All individuals were aged above 20 years, ranging from 20-70 years. Among these patients 45 were males and 56 were females. Gender distribution of BMI and IOP is given in table 1. The mean BMI in the diabetic with hypertensive subjects was 29.86 ± 5.87 while in diabetic without hypertensive subject was 27.49 ± 4.99 with p-value of 0.027 (Table 2) which is statistically significant. The mean IOP of both eyes in diabetic with hypertensive subject was 16.34 ± 0.34 , while in diabetic without hypertensive subject was 15.98 ± 0.43 with p-value of 0.579 (Table 2).

The association between the BMI and IOP was evaluated. There was a significant increase in IOP with increase in BMI in both groups (P value = 0.006, P value = 0.001) Table 3. Increase in IOP was strongly associated with increase in BMI in both diabetic with or without associated hypertensive adults.

Table 1: Age, BMI and Mean IOP distribution according to gender (n = 101).

Characteristics	Total	Male n (%)	Female n (%)
Age (Years)			
< 25	4	1 (25.0)	3 (75.0)
25 – 44	19	8 (42.1)	11 (57.9)
45 – 64	65	28 (43.1)	37 (56.9)
≥ 65	13	8 (61.5)	5 (38.5)
Body Mass Index (Kg/m²)			
< 24.9	28	15 (53.6)	13 (46.4)
25 – 29.9	35	18 (51.4)	17 (48.6)
≥ 30	38	12 (31.6)	26 (68.4)
Mean Intra Ocular Pressure (mmHg)			
< 15	28	15 (53.6)	13 (46.4)
15 – 19	56	24 (42.9)	32 (57.1)
≥ 20	17	6 (35.3)	11 (64.7)

Table 2: Comparison of BMI and Mean IOP within Diabetic and Diabetic hypertensive patients. (n = 101).

	D/HT	D/NHT	p-value*
Body Mass Index (Kg/m²)			
Mean ± SD	29.86 ± 5.87	27.49 ± 4.99	0.027
Mean Intra Ocular Pressure (mmHg)			
Mean ± SD	16.34 ± 0.34	15.98 ± 0.43	0.579

D/ HT - Diabetes Mellitus with Hypertension
 D/NHT Diabetes Mellitus without Hypertension
 *p-value calculated using Mann – Whitney Test

DISCUSSION

The IOP values increased with increasing age. Various studies have shown a positive association between increasing age and IOP¹³⁻¹⁵ however a study done on Japanese population^{16,17} showed a negative correlation. In another study done in Pakistan, IOP progressively

Table 3: Association of Mean IOP and BMI in Diabetic and Diabetic hypertensive group. (n=101)

Body Mass Index (Kg/m ²)	Mean Intra Ocular Pressure (mmHg)			
	D/HT		D/NHT	
	n	Mean ± SD	N	Mean ± SD
< 24.9	15	13.2 ± 0.8	13	12.5 ± 1.3
25 - 29.9	34	16.6 ± 1.2	22	16.4 ± 1.4
≥ 30	8	20.6 ± 1.2	9	20.0 ± 1.2
P-value*		0.006		0.001

D/ HT - Diabetes Mellitus with Hypertension
 D/NHT Diabetes Mellitus without Hypertension
 *P-value calculated using Kruskal – Wallis Test

increased with age in both sexes, and amongst the two sexes it was seen to increase more in females¹⁸ which matches with our study. A study done on Korean population showed the mean IOP of men was 15.8 ± 3.3 mmHg and 15.7 ± 3.3 mmHg for right and left eyes respectively, which was significantly higher than women (15.1 ± 3.1 mmHg).¹⁹ Another study conducted on a Taiwanese population reported that intraocular pressure showed a significant reduction with aging in men but not in women.²⁰

The Blue Mountains Eye Study²¹, the “Baltimore Eye Survey”²² and the “Barbados Eye study”²³ have studied the relationship between IOP and Diabetes Mellitus. The Barbados eye study have also showed the relationship of IOP with increase of arterial blood pressure. This study showed the relationship of systemic factors such as Diabetes and Hypertension to increase in IOP in an African population and results concluded that elevated IOP in groups that had increased prevalence of diabetes and hypertension.²³ Barbara E. K. Klein, Ronald Klein, and Karhryn L. P. Linton et al conducted the Beaver Dam Eye Study²⁴ 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.

Another study showed that the IOP values increased progressively in hypertensive patients without retinopathy, to the hypertensive with

retinopathy and diabetic hypertensive with retinopathy. This shows the increasing association between raised intra ocular pressure and evolution of systemic hypertensive disease and association with diabetes mellitus.²⁵

In our study the mean IOP of both groups (i.e diabetes mellitus with hypertension and diabetes mellitus without hypertension) were 16.34 ± 0.34 and 15.98 ± 0.43 respectively with p-value of 0.579 which is not statistically significant. This might be because of small sample size of our study and need more cross-sectional studies of larger sample size to evaluate the statistically significant relation between the IOP with diabetic and hypertensive subjects.

Various studies have shown that Obesity is an independent risk factor for increased IOP and there is a positive relationship with IOP²⁶⁻²⁸. In our study there is also strong association of IOP and BMI in both diabetic hypertensive and only diabetic group with statistically significant p-value of 0.006 and 0.001 respectively. Obesity leads to increased intra orbital adipose tissue which causes a raised episcleral venous pressure. This in turn will reduce drainage of the aqueous humour. Other factors that come into play include an increased blood viscosity through elevated blood cell count, hemoglobin and hematocrit. Both these factors contribute to increasing impedance in aqueous humour outflow.²⁹ A relation between obesity and IOP was also found in studies by Shiose et al¹⁸, Klein et al³⁰ and Bulpitt et al³¹ (Japanese, American and British populations, respectively). Another study done on the Korean population showed that the mean BMI was 23.9 for men and 23.7 for women, and was positively associated with IOP after adjusting for age, sex and mean blood pressure.¹⁹

CONCLUSION

There is positive association between increase BMI with increase IOP in both diabetic with or without associated hypertension.

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