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Original Research Article

A Comparative Study of Intraocular Pressure and Metabolic Syndrome in a Tertiary Care Centre in Eastern India

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Abstract

Background: Glaucoma, one of the leading causes of blindness worldwide, is a progressive optic neuropathy with characteristic optic disc damage and visual field defects for which Intraocular pressure is considered to be the only modifiable risk factor. Metabolic syndrome consisting of abdominal obesity, glucose intolerance, dyslipidemia and high blood pressure, has been proved to be associated with cardiovascular morbidity and mortality. Though several studies have revealed possible association of hypertension with primary open angle glaucoma, there is a gap in knowledge regarding association of IOP and metabolic syndrome in this part of India.

Methods: This cross-sectional study was conducted on 50 subjects with metabolic syndrome and 50 subjects without between 18 - 44 yrs. of age in a tertiary care institute. Detailed ocular examination, systemic examination & relevant laboratory investigations were done in the institution. Statistical analysis was done by SPSS (version 27.0; SPSS Inc)

Results: Mean intraocular pressure in cases was 17.7400± 1.2586 mmHg and in control13.8400± 1.3303 mmHg. This difference was statistically significant ($p<0.0001$). Several metabolic syndrome components (Waist circumference, systolic BP, Serum TG) were related to higher IOP compared to age matched control. Negative correlation was found between IOP and serum HDL.

Conclusion: Several components of metabolic syndrome were associated with higher IOP compared to the controls.

Key words - Metabolic syndrome, Intraocular pressure, Eastern India

Introduction

Metabolic syndrome (MetS) is a disease entity consisting of abdominal obesity, diabetes, glucose intolerance, dyslipidemia and high blood pressure.[1] Physical inactivity, tobacco - alcohol use, unhealthy diet, genetic factors - all of them are considered to be potentially important risk factors of MetS which in turn increases the risk for development of various cardiovascular diseases, insulin resistance and neurological complications. It has been studied that diabetes and hypertension are associated with retinopathy & cataract.[2,3] Several components of MetS have been found to have some role in regulating intraocular pressure (IOP). Increased orbital fat content and raised episcleral venous pressure in obesity cause resistance to aqueous humor outflow and thus an increase in IOP.[4,5,6] High serum Triglyceride (TG) level may act in the same way. Elevated ciliary artery

pressure in hypertension causes increased production of aqueous humor which in turn increases the IOP.[6,7] It is hypothesized that osmotic pressure changes and dysfunction of the autonomic nervous system in diabetes may increase IOP. [8,9,10]

Glaucoma, on the other hand, is a progressive optic neuropathy with characteristic optic disc cupping and visual field defects which may lead to optic nerve atrophy & permanent blindness.[11] It is one of the leading causes of blindness worldwide.[12] IOP is the most important and only modifiable risk factor for the development and progression of glaucoma.[13] Sudden increases in IOP can cause mechanical stress and ischemic damage of the retinal nerve fibre layer while sudden decreases in IOP can cause micro-bubble formation in microvasculature with resultant gas emboli and ischemic tissue damage.[14]Chronic elevation of IOP has been considered in the pathogenesis of primary open-angle glaucoma (POAG). Early detection and treatment of glaucoma is the only means to the prevention of blindness due to glaucoma. According to a study conducted by Park SS et al [15] in 2010, every 1 in 10 people develops MetS in their mid-30s. In India several studies conducted over various parts have consistently shown a high prevalence of MetS. Studies conducted over parts of eastern India showed that the prevalence of MetS is increasing in urban as well as rural population. [16,17,18,19,20] However, there is a lack of information on the association of IOP with various MetS components in our country. This study was conducted to measure IOP in subjects with and without MetS and compare.

Materials &Methods

This prospective study was conducted during February 2020 to July 2021 in the OPD and inpatient department of Ophthalmology and medicine with approval of institutional ethics committee in accordance with the declaration of Helsinki. Fifty (50) subjects with MetS between 18 to 44 yrs of age were selected randomly as case and fifty (50) subjects in the same age group without MetS were selected as controls. Consent was taken from each subject.

Subjects with diagnosed glaucoma, with history of use of systemic and/ or topical steroid, diabetic or hypertensive retinopathy, past ocular surgery and not willing to participate were excluded from the study.

Blood pressure (BP) was measured twice with a digital BP monitor after at least 10 minutes of rest and the average value was taken. Waist circumference (WC) was measured using standard measuring tape. Venous blood samples were collected after 8 hrs of fasting and tests for fasting glucose (FBS), triglyceride (TG) and high-density lipoprotein (HDL) done in institutional laboratory. MetS cases were diagnosed according to National Cholesterol Education Program-Adults Treatment Panel III (NCEP ATP III) guideline. [21]

Detailed ocular examination was done using slit lamp biomicroscope, fundus examination using +90D lens, estimation of IOP by applanation tonometry (with Goldmann applanation Tonometer), central corneal thickness measurements using Non-contact tonometer (Topcon) and visual field assessment with HFA-2. IOP was measured twice between 10 am to 8 pm and averaged. Statistical analysis was done by SPSS (version 27.0; SPSS Inc., Chicago, IL, USA) and P value < 0.05 was considered statistically significant.

Results

In this study, 36.0% of cases were between 18-30 years of age & 64 % between 31 - 44 years of age. In control group, 46% were in 18-30 year age group whereas 54.0% were in 31- 44 year age group (**Table 1**).

Table 1: Distribution of Age in case and control

Age In Group	Case	Control	TOTAL
18-30	18	23	41
31-44	32	27	59
TOTAL	50	50	100

Distribution of age in cases & controls was not statistically significant (p=0.0915).

Among cases, 60.0% were female and 40.0% were male &among controls 42.0% were female and 58.0% were male(**Table 2**).

Sex difference between cases & controls was not statistically significant.

Table 2: Profile of gender in cases & control

SEX	Case	Control	TOTAL
Female	30	21	51
Male	20	29	49
TOTAL	50	50	100

IOP in right eye (RE) in cases and controls were 17.7400± 1.2586 mmHg &13.8400± 1.3303 mmHg respectively. This difference was statistically significant (p<0.0001). IOP in left eye (LE) of cases and controls were 17.7600± 1.1168 mmHg &14.2800± 1.5258 mmHg respectively. This difference was also statistically significant (p<0.0001). (**Table 3**)

Table 3: Distribution of mean IOP (mm Hg)

		Number	Mean	SD	Minimum	Maximum	Median	p-value
IOP RE	Case	50	17.7400	1.2586	15.0000	20.0000	18.0000	<0.0001
	Control	50	13.8400	1.3303	12.0000	17.0000	14.0000	
IOP LE	Case	50	17.7600	1.1168	15.0000	20.0000	18.0000	<0.0001
	Control	50	14.2800	1.5258	12.0000	17.0000	14.0000	

Positive correlation was found between IOP RE with WC (P=.001), systolic BP (P=.029), FBS (P=.177) and serum TG (P=.001). Negative correlation was seen between IOP and serum HDLwhich was statistically significant (P=.006).

A positive correlation was found between IOP LE and WC (P=.020) but association with SBP (P=.102), FBS(P=.289) and serum TG (P=.140) was not significant. Negative correlation was found between IOP LE and serum HDL (P=.123).(**Table 4**)

Table 4: Correlation of IOP with all parameters

	IOP RE		IOP LE	
	p value, (r)		P value, (r)	
	Cases	Controls	Cases	Controls
Age (yrs)	.809(.035)	.188(.189)	.907(-.017)	.069(.259)
WC (cm)	.001(.602)	.980(-.004)	.020(.327)	.459(-.107)
SBP(mmHg)	.029(.308)	.351(.135)	.102(.234)	.722(-.052)
DBP(mmHg)	.967(-.006)	.658(-.064)	.637(-.068)	.445(-.111)
FBG(mg/dl)	.177(.194)	.080(-.250)	.289(.153)	.176(-.195)
Serum TG(mg/dl)	.001(.447)	.975(-.004)	.140(.212)	.040(.291)
Serum HDL(mg/dl)	.006(-.383)	.164(-.200)	.123(-.221)	.446(-.110)
WC- Waist circumference, SBP-Systolic blood pressure, DBP-Diastolic blood pressure, FBG- Fasting blood glucose, Serum TG- Serum Triglyceride, Serum HDL- Serum high density lipoprotein, Significant at< 0.05 level				

Discussion

India has a huge population with diverse ethnicity of which young adults and adults constitute a significant part.The median age of Indian population is 28.4yrs. [22] Metabolic syndrome is emerging as a dangerous life style disease and the prevalence of MetS particularly in young population is also increasing worldwide and in India[23,24]. According to a study conducted by Tanima Paul et al[4] a prevalence of MetS was found to be 4.5% among college students (18- 24 yrs of age) .Burden of glaucoma is not less in India as it has 11.9 million prevalent cases of glaucoma.[25] Elevated IOP is highly associated with the development of retinal ganglion cell death and thus glaucomatous changes.Sympathetic stimulation which has been associated with components of MetS like obesity, dyslipidemia and insulin resistance [26] increases production of aqueous humor. Further, endocannabinoid over activity has been found to have an important role in the patho-physiology of several components of MetS and these receptors are also found in the trabecular mesh work (TM) of rodents [27] which might have a role in production and regulation of aqueous humor. According to a study conducted by Mac Dougald OA et al, [28] aquaporin receptors have been found in TM and adipose tissue in human and these receptor activity are related to secretion of aqueous. This is how MetS and production and outflow of aqueous have common factors which may ultimately influence IOP. The normal mean IOP is 13.23 mmHg & 13.82 mm Hg in the age group of 20-29 yrs & 30-39 yrs respectively. **[**29**]** Mean IOP in our case group was higher (17.74± 1.2586 mmHg) compared to control (13.84± 1.3303mm Hg). This was statistically significant (p<0.0001). A positive and significant association was found between IOP with SBP and serum TG in cases of MetS.. Greater WC was associated with higher IOP (P-Value was 0.001& 0.020 in RE & LE respectively). According to Lee JS et al [30],only waist circumference and blood pressure had significant effects on IOP among metabolic components in korean population. Park SS et al [2] showed that IOP of subjects with central obesity (in men) and high blood pressure (in women) were significantly higher& those with more metabolic disturbances tended to have a greater IOP rise.

We found a positive correlation between IOP and SBP. According to The Beijing Eye Study [31] higher IOP was associated with diabetes, high pulse rate, higher DBP, higher BMI and larger waist and hip circumference in their normal population. Association of IOP and BP is a transethnic finding as suggested by the Beaver dam and the Blue Mountains study. Recent investigations by Reg R et al.[32] showed that BP, CSF pressure and IOP are associated with each other suggesting a common regulatory element of all these pressures. Though we got a negative correlation between IOP and DBP, the result was not statistically significant (*P*=.967& .068 in RE & LE respectively). FBS & serum TG had a positive correlation with IOP which was statistically significant (*P*=.001) in RE.A negative and statistically significant correlation was found between IOP and serum HDL (*P*=.006). Lee JS et al[30] found significant association between TG and IOP but not between IOP and HDL-cholesterol. Recent study done on turkish (also having a diverse ethnicity) population also showed that high BP, high TG, high FBS and abdominal obesity were significantly associated with a higher IOP. [33]

Being an institution based study, our study has a few limitations like small sample size and the details of history about drinking and physical exercises were not considered which might have influenced IOP. But this study has significant observation that the IOP in MetS was definitely on the higher range compared to the mean IOP of the age matched controls.

Conclusion

As the prevalence of metabolic syndrome is increasing even in younger age groups in India, more people are now at the risk of developing high IOP and therefore glaucoma in future. To the best of our knowledge this is the first study of its kind conducted in this region to show this association. Therefore a cohort study in future is essential to understand the magnitude of the problem. It will also help in developing awareness about the dangers of sedentary lifestyle and risk of glaucoma and thus need for adopting healthy lifestyle as well.

Declaration

Ethics approval and consent-This study was conducted in accordance with the ethical standard of the institutional ethics committee and with the Declaration of Helsinki (revised in 2013). Informed consent was obtained from all patients for being included in the study.

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