Original Article

Effect of Blood Pressure on Intraocular Pressure in Primary Open Angle Glaucoma

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Purpose: To determine the effect of change in blood pressure on intraocular pressure in primary open angle glaucoma patients coming to a tertiary care hospital.

Study Design: Cross sectional descriptive study.

Place and Duration of study: Ophthalmology department Karachi Medical and Dental College Abbasi Shaheed Hospital from January 2015-June 2016.

Material and Methods: Patients were registered through non probability consecutive sampling technique. Patients with Primary open angle glaucoma were included, secondary and angle closure glaucoma were excluded. Intraocular pressure and blood pressure was recorded. Data was collected and analyzed by using Statistical Package for Social Sciences (SPSS 21). Kruskal Wallis test was used to compare systolic blood pressure with median intraocular pressure of both eyes. Mann Whitney test was used to compare diastolic blood pressure with median intra ocular pressure of both eyes.

Results: There were 379 patients with mean age of 59.68 ± 11.37 SD. Males were 188 (49.6%). Mean IOP of right eye was 18.00 mm Hg ± 5.81 and left eye was 19 mm Hg ± 5.87. The median difference in inter quartile range (IQR) of IOP with Systolic blood pressure category > 140 mm Hg was 18 (16 – 19) mm Hg for right eye ($p<0.001$) was statistically significant. The median difference in IQR of IOP at diastolic blood pressure category 90–110 mm Hg was 18 (16 – 22) mm Hg for right eye and was also statistically significant. Median IQR of IOP right and left eye in males were statistically not significant as compared to females (0.908 & 0.978).

Conclusion: The intraocular pressure in primary open angle glaucoma patients increased with increase in blood pressure.

Key Words: Primary Open Angle Glaucoma**,** Diastolic blood pressure, Systolic blood pressure, intraocular pressure.

Although the effect of IOP in POAG is not clearly understood but increased IOP has always been one of the major risk factors in development and progression of POAG.

Almost all the experimental models for glaucoma show involvement of raised IOP. Many studies have given an improved understanding of the risk factors involved in POAG. Recently many new risk factors have been discovered which include thin central corneas, blood pressure and dibetes mellitus[1,2]. Effect of low or high blood pressure in developing POAG is not clearly understood. However the Blue Mountain Eye study[3], Egna Neumarkt glaucoma Study[4] and Rotterdam Eye study[5] reported that patients of systemic hypertension are vulnerable to develop POAG. In cases of chronically elevated blood pressure, rise in peripheral resistance and small vessal pathology can decrease optic nerve head perfusion.

On the other hand in light of vascular theory of development of POAG decrease in BP particularly during elevated intraocular pressure can change optic nerve head perfusion pressure leading to retinal ganglion cell ischemic damage[6]. Pyrecto Ver studies couldn't demonstrate any significant relationship[7]. Thus there is variability among the results of various studies which should not be surprising because relationship of IOP and BP is complex and is effected by many factors as effect of BP on IOP, use of antihypertensive and anti glaucoma drugs and hypertension duration.

We conducted this study to determine the effect of diastolic and systolic blood pressure on IOP in patients with POAG in a tertiary care hospital. Since no similar local studies have been conducted and published in our population up to our knowledge, so it will enhance our understanding of the disease and management plans in Primary Open Angle Glaucoma.

MATERIAL AND METHODS

The study was conducted at ophthalmology department of Abbasi Shaheed Hospital and Karachi Medical and Dental College from January 2015-June 2016. It was a cross sectional descriptive study. It was started after approval from Ethical Review Committee of the Hospital. Patients were registered through non probability consecutive sampling technique from outpatient department. Sample size calculated was 379[8] using open Epi sample size calculators for demographic studies version 3, keeping confidence interval 95% and Margin of error 5%.

Patients with POAG, 40 years and above, clear corneas to facilitate gonioscopy, Glaucomatous optic disc and Glaucomatous visual field defects were included in the study. Those patients having normal tension glaucoma, corneal opacities where gonioscopy was not possible, past ocular surgeries, close angle glaucoma and secondary Open Angle Glaucoma were excluded from the study.

Written and informed consent was taken from the patients. Detailed medical history was obtained. An ocular examination was conducted which included measurement of visual acuity, refraction, slit lamp examination and fundoscopy. Diagnosis of POAG was established by measurement of intraocular pressure with help of applanation tonometer, gonioscopy, typical glaucomatous field defects, glaucomatous optic nerve head damage and optical coherence topography (OCT). Topical anesthesia was instilled in each eye. Fluorescein strips were used for few seconds. Tonometer was adjusted at 10 mm Hg. Measurement was taken and recorded when the mires were just overlapping each other. Procedure was repeated in the fellow eye. Blood pressure of all the patients was measured and recorded with help of manual mercury sphygmomanometer. Three consecutive readings were taken in sitting position and for right side of the arm. Mean of the three readings was taken into consideration. All the findings were recorded on the predesigned proforma.

Data analysis was done on Statistical Package for Social Sciences (SPSS 21). Frequencies and percentages were computed for categorical data like age, gender, stages of hypertensive retinopathy, diabetics and tobacco users. Whereas means and median were calculated for continues data like IOP and blood pressure on parametric test Kruskal Wallis Test was used to compare systolic blood pressure with median intra ocular pressure of right and left eye. P-value less than 0.05 was taken as statistically significant. Mann Whitney test was used to compare diastolic blood pressure with median intra ocular pressure of both eyes. Mann Whitney test was also used to compare intraocular pressure, systolic and diastolic blood pressure with gender. P-value less than 0.05 was taken as statistically significant.

RESULTS

379 patients in our study and their mean age was 59.68 ± 11.37. Males were188 (49.6%) and females were 191 (50.4%). Mean intraocular pressure of right eye was 18.00 ± 5.81 and left eye was 19.00 ± 5.87. Mean systolic blood pressure of the patients was 146.86 ± 17.99 and diastolic pressure was 91.66 ± 9.63. Frequencies of tobacco users, diabetics and grading of hypertensive retinopathy were computed and given in table 1.

Statistical analysis showed the difference in median IQR (inter quartile range) of IOP in both eyes in Systolic blood pressure category>140 mm Hg was statistically significant. Median IQR (inter quartile range) of IOP right eye in Systolic blood pressure category > 140 mm Hg was 18 (16 – 19) mm Hg ($p = 0.015$). Median IQR (inter quartile range) IOP of left eye in Systolic blood pressure category > 140 mm Hg was also significant 19 (16 – 22) mm Hg ($p < 0.001$) (Table 2 and Fig. 1).

Furthermore, the median (inter quartile) difference of IOP right eye in diastolic blood pressure category

90 – 110 mm Hg was 18 (16 – 22) mm Hg which was statistically significant as compared to that of diastolic blood pressure category< 90 mm Hg (p < 0.001). The IOP left eye was also significantly higher 20 (16 – 24) mm Hg in diastolic blood pressure category 90 – 110 mm Hg (p < 0.001) (Table 3 and fig 2). The visual fields and OCT of these patients showed glaucomatous changes.

We also observed that median (IQR) of IOP right eye and left eye in males were not statistically significant as compared to females (0.908 & 0.978) given in Table 4.

The median (IQR) systolic blood pressure in males were statistically not significant as compared to females P = 0.697. The statistical analysis also revealed that diastolic blood pressure in males were higher as

Table 1: Demographics of the Patients enrolled in the study.

Demographic Characteristics	n (%)
Age*	59.68 ± 11.37
IOP*	
Right Eye	18.00 ± 5.81
Left Eye	19.00 ± 5.87
Blood pressure *	
Systolic blood pressure	146.86 ± 17.99
Diastolic blood pressure	91.66 ± 9.63
Gender ¥	
Male	188 (49.6%)
Female	191 (50.4%)
Grading of HTN Retinopathy¥	
Grade 0	95 (25.1%)
Grade 1	181 (47.8%)
Grade 2	95 (25.1%)
Grade 3	8 (2.1%)
Diabetics Patients¥	
Diabetics	103 (27.2%)
Non Diabetics	276 (72.8%)
Tobacco¥	
Tobacco User	207 (54.6%)
Non Tobacco User	172 (45.4%)

*continuous variables are presented as mean+/-S
Categorical variables are presented as frequencies and percentages

Table 2: Comparison of Systolic Blood Pressure with IOP.

Systolic BP	No. of Samples	IOP Right Eye	IOP Left Eye
< 120 mm Hg	44	16 (15 - 20)	16 (14 - 20)
120 - 140 mm Hg	111	16 (14 – 20)	16 (12 - 20)
> 140 mm Hg	224	18 (16 - 19)	19 (16 - 22)
p-value		0.015	< 0.001

P-value was calculated by Kruskal Wallis test. Median IQR were presented for continuous variables
P-value less than 0.05 was taken as significant

Table 3: Comparison of Diastolic Blood Pressure with IOP.

Diastolic BP	No. of Samples	IOP Right Eye	IOP Left Eye
< 90 mm Hg	220	16 (14 - 18)	16 (14 - 22)
90 - 110 mm Hg	159	18 (16 -22)	20 (16 - 24)
p-value		< 0.001	< 0.001

P-value was calculated by Mann-Whitney Test.
Median IQR was presented for continuous variables
*P-value less than 0.05 was taken as significant

Table 4: Comparison of IOP and BP with Gender.

Parameter	Gender		p-value
	Male (n=188)	Female (n=191)	
IOP Right Eye	18 (14 - 19)	16 (15 - 20)	0.908
IOP Left Eye	17 (16 - 22)	18 (14 - 22)	0.978
Systolic BP	151 (140 - 60)	150 (130 - 160)	0.697
Diastolic BP	90 (85 - 100)	90 (80 - 95)	0.051

P-value was calculated by Mann Whitney test. Median (IQR) was presented for continuous variables.

compared to females but the difference was not clinically significant(p = 0.052) given in table 4.

Statistical analysis showed the difference in median IQR (inter quartile range) of IOP in both eyes in Systolic blood pressure category>140 mm Hg was statistically significant.

DISCUSSION

Glaucoma has significant effects on health and economy of almost all the sectors of our society. Glaucoma is a disease where normal balance between IOP and BP in choroidal vessals supplying the optic nerve head and the reterolaminar portion of optic nerve is disrupted which results in vascular insufficiency at the optic nerve and reterolaminar portion of optic nerve. Thus resulting in pathological changes in optic disc, optic nerve and typical visual field defects[9].

The exact pathogenesis of POAG remains unclear but raised IOP is one of the major risk factor in addition to other factors that affect the blood supply of optic nerve head. The etiology of POAG is multifactorial. But some factors like blood pressures are modifiable which can be controlled to halt the progression of glaucomatous damage[1].

We conducted this study to see the effect of systolic and diastolic BP on IOP in patients of POAG. Total number of patients was 379 and their mean ages were 59.68 ± 11.37. Males were188 (49.6%) and females were 191 (50.4%). Mean intraocular pressure of right eye was 18.00 ± 5.81 and left eye was 19 ± 5.87. Mean systolic blood pressure of the patients was 146.86 ± 17.99 and diastolic pressure was 91.66 ± 9.63.

In our study the patients with systoloic blood pressure of more than 140mm Hg have significant rise in IOP of right and left eye with p value of less than 0.005. Similarly Sadiqulla et al have reported an increase in IOP with rise in BP in diagnosed patients of POAG. They have reported an IOP of 29 mm Hg in systolic BP category of 40-149 mm Hg and an IOP of 32 mm Hg in systolic BP category of >160 mm Hg[8]. This difference in mean IOP could be due to large sample size and the patients we included were already on anti glaucoma medications.

Leske and et al have also documented a positive relationship between high diastolic BP and IOP in patients with POAG[10]. A large number of studies including Caucasians (Blue Mountain eye study, Egna Neumarkt glaucoma study and the Rotterdam eye study) Africans (Barbados eye study) and Asians (Tanjong Pagar study) found that systemic hypertension increases susceptibility to glaucoma[1,3,4,5]. As these studies have large sample size with various ethnic backgrounds so they have a wide applicability.

A meta-analysis conducted in 2014 found the association between association between blood pressure and intraocular pressure. Sixty observational studies were included in it. Almost all studies have reported a positive association between BP and IOP. The average increase in IOP with a 10 mm Hg increase in systolic blood pressure was 0.26 mm Hg, and average rise of IOP with 5 mm Hg diastolic blood pressures was 0.17 mm Hg. [11] While our study reported the rise of IOP in systolic group and diastolic group but it was more marked in diastolic group.

A literature review revealed most of the studies showing a strong relationship between glaucoma and high blood pressure while there are certain studies that have linked glaucoma with high blood pressure[1].

This association between glaucoma and high blood pressure seems controversial because high BP should give an increased ocular perfusion pressure so it should provide a protective effect. Although there is a positive relationship between BP and IOP, there is small change in IOP with rising BP. So the risk of development of glaucoma with increase in blood pressure couldn't be completely associated with BP driven rise in IOP[12]. The authors of Baltimore Eye Survey reported that association between glaucoma and BP is age dependent. They speculated that the optic nerve is aided from increased blood pressure when blood vessels are normal in young age, but as vassals become atherosclerotic, rigid and with age the resistance to blood flow will be increased, there will be oxygen deficiency, disturbed vascular auto regulation and nutrient exchange at capillary beds so high blood pressure is no longer effective. Impaired auto regulation means that there is a decreased ability of eye to resist episodes of decreased ocular perfusion pressures and over the passage of time the cumulative effect can cause loss of ganglion cells [12]. On the other hand an increase in blood pressure results in elevation of cilliary artery pressure, thus increasing the aqueous production and resulting in rise of intraocular pressure. As rise in arterial pressure can cause a small rise in venous pressure, so aqueous clearance will be reduced, which is also a contributing factor towards a high IOP[13,14].

The Los Angeles Latino eye Study[1] reported that both high systolic and low diastolic blood pressures

have an association with an increased prevalence of POAG[15].

The Barbados Eye Studies, Thessaloniki Eye Study and Early Manifest Glaucoma Trial reported an association of POAG with low blood pressure .Rapid and large reductions in blood pressure result in reduced ocular perfusion pressure which increases the risk for glaucoma[1,16,17]. Clinically it is important that not only IOP but also the blood pressure status of the patients in POAG should be taken in consideration. Onakoya and Dielemans have reported a positive association between systemic hypertension and POAG in their studies[18,19].

It is important to avoid over or under treatment of chronic hypertensive patients to get an optimal ocular perfusion pressure range. Glaucoma is believed to be a vascular disease. We can actually visualize arterioles at retina which supply the ganglion cells. An increase in BP may lead to increase ganglion cell death which may be a contributing factor towards glaucoma. It is important here to highlight that in our study we had 47.8% patients with grade 1 hypertensive retinopathy and about 25.1% patients had grade 2 hypertensive retinopathy, along with established diagnosis of POAG. So rise in blood pressure could be a contributory factor towards glaucomatous damage. It was reported in a study that patients having with hypertensive retinopathy presented with greater intraocular pressure readings as compared to those who had no hypertensive retinopathy[20].

Since we did not have any similar studies in our population to compare the results so we have to compare the results with that of the developed countries.

CONCLUSION

Intraocular Pressure in patients with Primary Open Angle Glaucoma rises as there is a rise in systolic as well as diastolic blood pressure. Intraocular pressure is not affected by genders. So it is important to have a good control of blood pressure in patients of POAG to halt or slow down the progression of glaucomatous optic nerve damage.

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