ORIGINAL ARTICLE

Relationship of Systemic Blood Pressure, Intraocular Pressure and Ocular Perfusion Pressure

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ABSTRACT

Aim: To study the relationship of systemic BP with intraocular pressure and ocular perfusion pressure
Study design: Cross sectional study
Place: Combined Military Hospital Lahore and Arif Memorial Teaching Hospital Lahore.
Methods: Patients reporting in OPD were included in the study. Patient with Cataract, Glaucoma and eye trauma were excluded from the study. Intraocular pressure was measured in both eyes by Applanation Tonometry. Systolic Blood pressure (SBP) and Diastolic blood pressure (DBP) measurements were performed and mean arterial blood pressure (MABP) and Mean ocular perfusion pressure (MOPP) were calculated. Data was analyzed by SPSS version 18. Pearson Correlation coefficient was calculated to identify the relation of systemic blood pressure with IOP and MOPP. Linear regression analysis was run with IOP and MOPP as the dependent variable and blood pressure, age and gender as the independent variables. P value <.05 was considered significant.
Results: A total of 120 patients were included in the study, 63(52.5%) were male and 57(47.5%) were females. On running Pearson correlation coefficient IOP right eye was significantly associated with SBP(p.011),DBP (p.045), MABP(p.015) and pulse pressure (p.036).Similarly IOP Lt eye was strongly associated with SBP(p.001),DBP (p.031),MABP (p.003) and pulse pressure (p.002).Age and IOP had a positive correlation but it was not statistically significant(p.053).On linear regression analysis IOP was strongly associated with MABP (p.015), SBP (p.011),DBP (p.045) and pulse pressure (p.036) and corresponding regression coefficients were .059,.039,.06 and .045 per mm of Hg increase in IOP per mm Hg increase in MABP,SBP,DBP and pulse pressure, respectively. Similarly, MOPP was strongly associated with MABP (p<.001), SBP (p<.001), DBP (p<.001) and pulse pressure(p<.001) and corresponding regression coefficients were .607,.351,.699 and .045 per mmHg increase in MOPP per mm Hg increase in MABP,SBP,DBP and pulse pressure, respectively.
Conclusion: Intraocular pressure and mean ocular perfusion pressure is strongly associated with Mean arterial blood pressure, Systolic blood pressure, diastolic blood pressure and pulse pressure. As compared to intraocular pressure, the mean ocular perfusion pressure has more significant and powerful correlation with blood pressure.
Keywords: Intraocular pressure, ocular perfusion pressure, mean ocular perfusion pressure

INTRODUCTION

Various population based studies have shown the fact that intraocular pressure (IOP) is related to systemic blood pressure[1]. In addition to blood pressure, the intraocular pressure is affected by many factors like age gender, body mass index, hematocrit, serum glucose, glycosylated hemoglobin, cholesterol level, pulse, nuclear sclerosis, central corneal thickness (CCT), season, and time of day of measurement[2-6]. Blood pressure itself is a very dynamic entity and influenced by so many diverse factors, that may affect not only systemic blood pressure but intraocular pressure as well. The interplay between systemic blood pressure and intraocular pressure in turn defines the ocular perfusion pressure. Fluctuations in ocular perfusion pressure has been implicated as an important factor in optic nerve blood flow ,ocular blood flow, development of glaucoma and progression of visual field defects[7-11] The exact relationship of these factors and their role in pathogenesis of glaucoma and other eye diseases is still obscure and there is no consensus opinion in a list of studies on the subject[12-14]. Further studies and investigations in this aspect are the need of time. In the local literature the relationship has been studied by very few researchers .We devised a study to identify the relationship of systemic blood pressure with IOP and ocular perfusion pressure.

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MATERIALS AND METHODS

This cross sectional study was carried out at Combined Military Hospital Lahore and Arif Memorial Teaching Hospital Lahore. Patient reporting in Out Patient Department of both hospitals were included in the study. Patient with Cataract, Glaucoma and eye trauma were excluded from the study. Intraocular pressure was measured in both eyes by Applanation Tonometry. The cornea was anaesthetised with topical 0.5% proparacaine hydrochloride eye drops. The readings were recorded on same Applanation tonometer. Systolic Blood pressure (SBP) and Diastolic blood pressure (DBP) measurements were performed in sitting position on right arm using Mercury sphygmomanometer. The mean arterial blood pressure (MABP) and Mean ocular perfusion pressure (MOPP) were calculated as[15]

Pulse pressure= SBP – DBP

MABP = DBP + (Pulse Pressure×1/3)

MOPP = MABP – IOP.

The Systolic ocular perfusion pressure (SOPP) and diastolic ocular perfusion pressure (DOPP) were calculated by subtracting the IOP from the SBP and DBP, respectively. IOP of right eye was used to calculate MOPP, SOPP and DOPP. Data was collected through a carefully designed structured data collection form and analyzed by SPSS version 18. Frequencies and percentages of different variables were calculated. Comparison of means was done by student t test and frequencies and percentages were compared by chi square test and fisher exact test. Paired sample T test was used to compare mean pressures in right and left eye. Independent sample T test was used to compare means in male and female. Pearson Correlation coefficient was calculated to identify the relation of systemic blood pressure with IOP and MOPP. Linear regression analysis was run with IOP and MOPP as the dependent variable and blood pressure, age and gender as the independent variables. This model was run for different blood pressure variables: MABP, SBP, DBP and pulse pressure. P value <.05 was considered significant.

RESULTS:

A total of 120 patients were included in the study, 63(52.5%) were male and 57(47.5%) were females. Descriptive statistics of all the patients are shown in table1. Mean age, mean arterial pressure, mean pulse pressure, mean intraocular pressure and mean perfusion pressure did not show any statistical significant difference between male and female. Comparison of IOP, MOPP, SOPP and DOPP, in right and left eye was not statistically significant (p.0122). On running Pearson correlation coefficient IOP right eye was significantly associated with SBP(p.011),DBP (p.045), MABP (p.015) and pulse pressure (p.036).Similarly IOP Lt eye was strongly associated with SBP (p.001),DBP (p.031),MABP (p.003) and pulse pressure (p.002). Age and IOP had a positive correlation but it was not statistically significant (p.053).On linear regression analysis IOP was strongly associated with MABP (p.015), SBP (p.011), DBP (p.045) and pulse pressure (p.036) and corresponding regression coefficients were .059,.039,.06 and .045 per mm of Hg increase in IOP per mm Hg increase in MABP, SBP, DBP and pulse pressure, respectively. The percentages of variance (R^2) in IOP explained by the MABP SBP, DBP and pulse pressure were 5%, 5.4%, 3.3% and 3.7%, respectively. Similarly ,MOPP was strongly associated with MABP (p<.001), SBP (p<.001),DBP (p<.001) and pulse pressure(p<.001) and corresponding regression coefficients were .607,.351,.699 and .045 per mm of Hg increase in MOPP per mm Hg increase in MABP,SBP,DBP and pulse pressure, respectively. The percentages of variance (R^2) in MOPP explained by the MAP SBP, DBP and pulse pressure were 84.5%, 71%, 75.2% and 30.5%, respectively.

Table 1: Descriptive statistics

	Minimum	Maximum	Mean	Std. Deviation
Age	13	79	52.17	14.052
Intraocular Pressure Rt Eye	8	24	14.65	3.372
Intraocular Pressure Lt Eye	10	24	14.45	3.040
Systolic Blood Pressure	90	210	130.96	20.045
Diastolic Blood Pressure	50	110	83.21	10.347
Mean Arterial Blood Pressure	63.33	143.33	99.1250	12.63205
Pulse Pressure	10	100	47.75	14.346
Mean Ocular Perfusion Pressure Rt Eye	24.22	77.56	51.4333	8.34567
Systolic Ocular Perfusion Pressure Rt Eye	72.00	192.00	116.3083	19.54043
Diastolic Ocular Perfusion Pressure Rt Eye	32.00	98.00	68.5583	10.27913
Mean Ocular Perfusion Pressure Lt Eye	28.22	77.56	51.6333	8.15839
Systolic Ocular Perfusion Pressure Lt Eye	76.00	192.00	116.5083	19.35471
Diastolic Ocular Perfusion Pressure Lt Eye	36.00	98.00	68.7583	10.19391

DISCUSSION

Various population based studies have shown that intra ocular pressure is related with systemic blood pressure. Ocular perfusion pressure mainly depends on blood pressure and intraocular pressure. Age, gender, body mass index ,posture and diurnal variations all affect systemic blood pressure and IOP[4,16]. Changes in IOP and BP in turn affect the ocular perfusion pressure.as MOPP calculation is based on MAP, pulse pressure and IOP.A higher MOPP is presumed to decrease the risk of open angle glaucoma (OAG) and paradoxically, high blood pressure might increase the risk of OAG by decreasing the optic nerve perfusion resulting from reduced vessel diameter. This association becomes somewhat confusing and complex when IOP contribution to development of OAG is considered because blood pressure is positively associated with IOP. In this way systemic hypertension is considered to indirectly increases the risk of OAG[15]. We have quantified the correlation of systemic blood pressure with IOP and MOPP in our study.

Study by Bulpitt in 1975 described that intraocular pressure was positively and independently related to systemic blood pressure and obesity. He concluded that Systolic pressure rather than diastolic or mean pressure was most closely correlated with IOP.[2] Our study has revealed that there is positive and statistically significant relationship of MABP, SBP, DBP and pulse pressure with IOP. Among all four blood pressure variables, SBP was most significantly related to IOP.

In 2005 Beaver Dam Eye Study by Klein identified that intraocular pressures were significantly correlated with systolic and diastolic blood pressures 0.21 and 0.43 mm Hg increase in IOP for a 10 mm Hg increase in systolic and diastolic blood pressure, respectively.[1] Results of our study are in line with this study but study by Klein involved the blood pressure and IOP measurement at base line and at five year interval, while our study was a cross sectional study involving a single measurement. We correlated IOP with MAP, SBP, DBP and pulse pressure while Klein correlated only SBP and DBP with IOP.

Kawase in 2008 in a study deduced that higher mean blood pressure (B = 0.022/mm Hg, p<0.0001 was significantly correlated with higher IOP[4]. Our study demonstrated the same result but in our study the regression coefficient or B was 0.059/mmHg, (p0.015)

Wong[5] in 2009 substantiated that age ,CCT, and SBP were all significant determinants of IOP. Tielsch[17] in 1995 and Werne[18] in 2008 explained that changes in blood pressure affect the ocular perfusion pressure, and ocular blood flow and a lower MOPP is a risk factor for glaucoma. Our study has also shown that MOPP is dependent on MABP, DBP, SBP and pulse pressure though we did not study its contribution to development of glaucoma.

Ramdas in 2011 assessed the relationships between IOP and the blood pressure variables MABP, SBP, and DBP. We have almost replicated the same study but added pulse pressure and MOPP as two additional variables. He concluded that IOP was strongly associated with all three variables (P < 0.001) and corresponding regression coefficients were 0.035, 0.025, and 0.029 mm Hg increase in IOP per mm Hg increase in MABP, SBP, and DBP, respectively. The percentages of variance (R^2) in IOP explained by the MABP, SBP, and DBP were 2%, 2.5%, and 1%, respectively[15]. In our study in case of IOP, all four blood pressure variables (MABP, SBP, DBP and pulse pressure) displayed a similar regression coefficient but a higher percentage of variance (R^2) 5%, 5.4%, 3.3% and 3.7%, respectively. In addition our study has revealed that MOPP is another appropriate variable that is strongly related to MABP, SBP, DBP and pulse pressure as evident by (p<0.001) and a much higher percentages of variance (R^2) in MOPP explained by the MAP SBP, DBP and pulse pressure 84.5%, 71%, 75.2% and 30.5%, respectively.

Our study did not include the impact of MABP, SBP, DBP, pulse pressure and MOPP on the development of glaucoma and visual field defects. We recommend a large scale study in hypertensive patients to investigate the impact of MOPP and blood pressure on development of glaucoma and visual field defects as well as the effect of antihypertensive medicines on IOP and MOPP.

CONCLUSION

We conclude that intraocular pressure and mean ocular perfusion pressure is strongly associated with Mean arterial blood pressure, Systolic blood pressure, diastolic blood pressure and pulse pressure. As compared to intraocular pressure, the mean ocular perfusion pressure has more significant and powerful correlation with blood pressure. However, the clinical significance of this correlation and its role in pathogenesis of glaucoma need further studies and investigations.

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