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Original research article

To Determine the Clinical Association between Glaucoma and Systemic Hypertension, as well as the Impact on Visual Morbidity

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Abstract

Aim: To evaluate the clinical correlation of glaucoma with systemic hypertension and its effect on visual morbidity.

Methods: This was a prospective study conducted in the Department of Ophthalmology, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India, for 15 months. It was carried out on 110 patients ranging in age from 30 to 70 years old, including recently diagnosed hypertensives as well as previously diagnosed hypertensives that were now undergoing medication and being followed up on. According to new American Heart Association guidelines, hypertensive patients had blood pressure readings of >120/80 mm Hg on two different occasions. Calcium channel blockers (CCB), diuretics, angiotensin transforming enzyme inhibitors (ACE), angiotensin receptor blockers, and beta blockers were the five types of oral hypotensive drug used among the patients. **Results:** Among the 110 hypertension patients involved in the study, 66 patients (60%) were female and 44 patients (40%) weremale. Age group affected was 15.45% between 30-40 years, 31.82% between 40 to 50 years and 52.73% above 50 years, the mean age being 57.7 years. Hypertensive patients diagnosed with having glaucoma had a mean duration of 4.87 years. Among the 45 newly diagnosed patients 30 patients had glaucoma and 15 patientsdid not have glaucoma. They had been on oral hypertensionmedications for a duration ranging from 1 month to 6months. The oral hypotensive medication taken by patients were categorized into 5 groups as calcium channelblockers(CCB), diuretics, angiotensin converting enzyme inhibitors (ACE inhibitors), angiotensin receptor blockers (ARB) and beta blockers.

Conclusion: Hypertension can cause both reduction and elevation in IOP. Treatment of hypertension does lower the IOP and prevent further progression of glaucoma and prevent any visual loss.

Keywords: Hypertension, glaucoma, IOP

Introduction

Glaucoma is a chronic progressive optic neuropathy characterized by retinal ganglion cell death and associated visual field loss.[1] The exact pathophysiological mechanism of optic nerve damage in glaucoma is not fully understood.[2] Besides the mechanical effect of raised intra ocular pressure (IOP) on optic nerve head (ONH), several vascular risk factors such as systemic hypertension, atherosclerosis, vasospasm etc., have also been implicated as potential factors capable of increasing the risk of open-angle glaucoma (OAG).[2]

Vascular risk factors such as systemic hypertension, atherosclerosis, and vasospasm have been recognized as potential factors that are capable of increasing the risk of primary open-angle glaucoma (POAG) and normal tension glaucoma (NTG).[3,4] It has been hypothesized that low blood pressure (BP) relative to IOP leads to low ocular perfusion pressure (OPP) of the optic

nerve leading to glaucomatous disc changes and visual field loss.[3,5] Chronically elevated BP leads to arteriosclerotic changes and changes in the size of the precapillary arterioles which gives rise to increased resistance to blood flow and hence reduced perfusion.[6] In the Blue Mountain Eye Study and the Egna-Neumarkt study, the association has been found between POAG and systemic hypertension.[7,8] In contrast, studies performed by Deb et al. and Vijaya et al. have reported no significant association between the two.[9-11] Recent literature suggests that the measurement of OPP is a highly relevant parameter in open-angle glaucoma patients.[12] Fluctuations in the OPP is a known contributing factor in the development of glaucomatous disc changes in the subgroup of POAG, as known as NTG.[13] It has also been observed that individuals on antihypertensive medications were 2–3 times more likely to be affected by glaucoma. This may be attributed to the bedtime dosage of antihypertensive drugs which cause a drop in nocturnal BP, eventually leading to a reduction in OPP.[9] A study performed by Pache and Flammer reported a nocturnal dip in BP as an important risk factor for POAG.[14] The Thessaloniki eye study noted that lowering of BP from antihypertensive treatment was associated with glaucomatous changes.[15]

Material and Methods

This was a prospective study conducted in the Department of Ophthalmology, Darbhanga Medical College and Hospital, Laheriasarai, Darbhanga, Bihar, India, for 15 months. after taking the approval of the protocol review committee and institutional ethics committee.

Methodology

It was performed on 110 patients between the age groups of 30 to 70 years which included newly diagnosed hypertensives and previously diagnosed hypertensives receiving treatment and on follow up now. Patients with other systemic diseases or vascular pathologies were excluded from the study. Those with hypertension but less than 30 years of age were not enrolled into the study as both glaucoma and hypertension could be due to congenital causes in young individuals. All patients had a minimum follow up of 6 months and the need for regular review visits was explained to them. During the first visit and each follow up opinions regarding the progress of hypertension was obtained from departments of cardiology, internal medicine and neurology.

Patients are classified as hypertensive based on elevated BP readings of >120/80 mm Hg on two separate occasions according to current American Heart Association. Blood pressure measurements were made over 3 visits and the average of last two measurements was used for analysis. Recording was done with manual sphygmomanometer. The oral hypotensive medication taken by patients were categorized into 5 groups as calcium channel blockers(CCB), diuretics, angiotensin converting enzyme inhibitors (ACE), angiotensin receptor blockers and beta blockers.

Data collection

A detailed history of age, sex, duration of hypertension, history of other co morbidities and treatment were collected. The participants then underwent a detailed ophthalmological evaluation including visual acuity, anterior segment evaluation using slit-lamp bio-microscopy and fundus evaluation using a + 90 D lens/ indirect ophthalmoscope. IOP measurement was done by applanation tonometry with Goldman Applanation Tonometer. Fluorescein was instilled in each eye and the tonometer was set at 10mmHg. Mires were viewed through the prism and measurements were read from the rotating dial. The same procedure was repeated in the other eye. Phasing technique of repeating recordings was done and the average IOP was

used in the study. Gonioscopy was performed and the visual field of patients was analysedusing Humphrey visual field analyser.

Statistical Analysis

IBM SPSS analytics programme 20 Edition was used to evaluate the collected data. For categorical variables, frequency analysis and percentage analysis were used, while for continuous variables, the mean and standard deviation were used. The unpaired sample t-test was used to see whether there was a substantial difference between the bivariate samples of independent categories. The Chi-Square test was used to determine the importance of categorical results. The probability value of 0.05 was found important in all of the above statistical tools.

Results

Among the 110 hypertension patients involved in the study, 60 patients (54.54%) were found to have glaucoma. 66 patients (60%) were female and 44 patients (40%) weremale. Age group affected was 15.45% between 30-40 years, 31.82% between 40 to 50 years and 52.73% above 50 years, the mean age being 57.7 years.

Hypertensive patients diagnosed with having glaucoma had a mean duration of 4.87 years. Among the 45 newly diagnosed patients 30 patients had glaucoma and 15 patientsdid not have glaucoma. They had been on oral hypertensionmedications for a duration ranging from 1 month to 6months.

Type of glaucoma associated with systemic hypertensionwas primary open angle glaucoma (POAG) in 7 patients (15.56)%, ocular hypertension (OHT) in 37 patients (84.44%)and normal tension glaucoma (NTG) in 1 patients 2.22%.The increased incidence of OHT among hypertensives wasstatistically significant with a p value of 0.01. We did not see any association with angle closure glaucoma or secondary open angle in any of our patients.

In those with OHT, predominant fundus changes were seen as increased cup disc ratio in 14.54% and neuroretinal thinning in 10.91%. Visual field analysis showed nasal step with isolated scotomas in the Bjerrum's area as the commonest change in 6.36% patients. Corneal thickness in patients diagnosed with ocular hypertension was on an average 0.742. +/-0.02mm. Thicker cornea was noted in 30.91%. Thinner cornea was noted in 1.82% of patients.

The oral hypotensive medication taken by patients were categorized into 5 groups as calcium channelblockers (CCB), diuretics, angiotensin converting enzyme inhibitors (ACE inhibitors), angiotensin receptor blockers (ARB) and beta blockers. Total number of patients taking oral hypertensives was 75. In the group on medications therange of IOP was between 14- 26 mmHg.

Decreased IOP was highest among patients taking CCB in 24 patients (48%), followed by beta blockers in 3 patients (33.33%), ACE inhibitors11 patients (34.37%), ARB 6 patients (42.86%) and diuretics in 1 patient (20%). The range of IOP in the treated population was between 10-16mmHg and this difference in those on hypertension medications was statistically significant.

Table 1: Demographic profile

Gender	**Number of patients**	**Percentage**
Male	66	60
Female	44	40
Age in years		
30-40	17	15.45
40-50	35	31.82

Above 50	50	52.73

Table 2: Hypertension duration and glaucoma association

HTN Duration		N	Mean	STD Deviation	P Value
Glaucoma	Yes	45	4.87	4.558	0.681
	No	65	7.37	4.765	

Hypertension medication and IOP reduction			
Medication	Glaucoma		Total
	No	Yes	
CCB	26	24	50
	52%	48%	100%
Diuretics	4	1	5
	80%	20%	100%
ACE inhibitors	21	11	32
	65.63%	34.37%	100%
ARB	8	6	14
	57.14%	42.86%	100%
Beta blockers	6	3	9
	66.67%	33.33%	100%
Total	65	45	110
	59.09%	40.91%	100%

Discussion

The present investigation revealed that increases in IOP are linked to changes in systemic blood pressures in a clear and meaningful way. As IOP is probably the most important risk factor for glaucoma in general populations, this suggests that blood pressure treatment may have an effect on the risk of developing glaucoma. We previously discovered that those with higher IOP at baseline had a higher cup:disc ratio five years later. Although our results do not conclusively prove that lower blood pressure reduces the likelihood of glaucoma, they are consistent with the probability.[16]

This triggers an increase in aqueous fluid filtration through the ciliary body, resulting in an increase in IOP.[17] The episcleral venous pressure, which controls the aqueous flow through the trabecular meshwork by Schlemms canal, is also affected by high blood pressure.[18] However, we discovered that increased diastolic BP was more often associated with increased IOP in our patients.

Following different studies, it has been recorded that any 1mm rise in perfusion pressure correlates to a 1mm increase in IOP. Sodium transport in the distal nephrons and ciliary epithelium is altered, resulting in increased sodium excursion into the renal filtrate and aqueous humour, respectively. Corticosteroid hormones (cortisol and aldosterone) and glucocorticoid and mineralocorticoid receptors play a role in this.[19]

Primary open angle glaucoma (POAG) was shown to be associated with systemic hypertension in 7 patients (15.56%), ocular hypertension (OHT) in 37 patients (84.44%), and regular tension glaucoma (NTG) in 1 patient (2.22%) in this research. With a p value of 0.01 the increased incidence of OHT among hypertensives was statistically important. OHT was the most

prevalent form of glaucoma in our research, and it was related to anatomical and functional changes in the optic nerve head and visual fields. The literature has already proven that a thinner or thicker cornea will result in IOP readings that are higher or lower than the actual value. Until beginning glaucoma therapy, a correction to the reported IOP must always be made depending on the pachymetry readings.

Reduced IOP readings were associated more in patients taking CCB, ACE inhibitors and ARB drugs. This is in concurrence with Langman et al. who stated that IP association showed increased odds ratio in hypertensive patients taking CCB, ACE inhibitors and ARB drugs.[20] Klein et al. stated that beta blocker drugs had a protective effect for glaucoma and hypertension.[21] In our study we noted that those on calcium channel blockers had least involvement of the ONH but those on beta blockers had lowest recordings of IOP. This variation of effects on glaucoma has not been reported in previousstudies to the best of our knowledge. Leske et al. found that antihypertensive drugs was not associated with any increased risk of open angle glaucoma but that ocular perfusion pressure has a significant effect on IOP.[22] From our cohort of patients we found that oral anti hypertensive drugs does have beneficial effect in the control of IOP.

In our study decreased IOP was highest among patients taking CCB in 24 patients (48%), followed by beta blockers in 3patients (33.33%), ACE inhibitors 11 patients (34.37%), ARB 6 patients (42.86%) and diuretics in 1 patient (20%). The range of IOP in the treated population was between 10-16 mmHg and this difference in those on hypertension medications was statistically significant.

However we feel that systemic beta blockers are anotherimportant factor that would have to be considered as they may mask an elevated IOP making a diagnosis of glaucomadifficult. IOP though only a risk factor is important because it is the only treatable factor in glaucoma thatcan secondarily prevent progression of changes in the opticnerve head or visual field. Specifically, ACE inhibitors caused reduction in IOP only on long term use (greater than 1 year) although widelyprescribed as antihypertensive agents. Calcium channel blockers and beta blockers in combination with CCB can increase ocular blood flow and thus play a neuro protectiveeffect by reducing apoptosis of neurons.

Different anti hypertensive medications are chosen basedon associated heart failure or other systemic diseases and knowledge of the effect on IOP will be useful.[23] Betablockers are not preferred in heart blocks or pulmonary obstructive disease and in such situations ACE inhibitors are used. CCB are usually second line agents.[24] Another important facet of treatment to be considered is that topicalbeta blockers in glaucoma management are not efficient in those on systemic beta blockers and hence treatment will have to be titrated accordingly.

There is an increased risk of glaucoma with both high and low BP. Drugs that can lower BP may sometimesincrease the incidence of glaucoma due to specific effects on the optic nerve head. The exact cause of this complex relationship has not been understood but various influencingfactors such as relationship between blood pressure and ocular perfusion pressure, dysfunctional autoregulation andperipheral vascular capacity have been suggested.[25] We found that the risk of glaucoma in hypertension is higher in women. Among all drugs used in the treatmentof hypertension we concluded from our study that beta blockers protect and calcium channel blockers and ACE inhibitors have a lesser effect on glaucoma. The limitation of the study was that the sample size and duration of study was less and a longer follow up could have provided more insight into disease progression. Hypertension and IOP havecommon

biomechanical alteration in their pathogenesis.[26] Treatment of hypertension does lower the IOP and prevent further progression of glaucoma and prevent any visual loss.[27] A multidisciplinary approach which involves the ophthalmologist and treating physician will help in holistic monitoring the patient.

Conclusion

The present study concluded that the hypertension can cause both reduction and elevation in IOP. Treatment of hypertension does lower the IOP and prevent further progression of glaucoma and prevent any visual loss.

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