Original Article

A study on the effect of systemic hypertension on retinal nerve fibre layer thickness in West Bengal

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Retina is the innermost layer of the eyeball. The Retinal nerve fibre layer (RNFL) also known as the Stratum Opticum essentially consists of nonmyelinated axons of Ganglion cells, which in turn form the second order neurons of the visual pathway. It is to be noted in this regard that Glaucoma, a form of optic neuropathy, is characterized by optic nerve damage as evidenced by retinal nerve fibre layer defects. Several studies conducted worldwide have identified certain risk factors for glaucoma, systemic hypertension being one of them. Whether this factor decreases the retinal Nerve Fibre Layer Thickness in apparently normal individuals is yet to be established. The present work aims to study various aspects of this presumed determinant, that is, systemic hypertension on the retinal nerve fibre layer thickness in middle aged and elderly subjects of West Bengal and related risks of visual impairment associated with this factor. An observational and cross-sectional study was undertaken to achieve the above objectives. Both eyes of 380 subjects of both sexes and aged above 40 years were examined and the results were recorded. Systemic blood pressure in all of them was recorded. Stratus Optical Coherence Tomograph (OCT) was used for Peripapillary Fast Retinal Nerve Fibre Layer thickness assessment of both eyes. Our study revealed that there is statistically significant reduction of Retinal Nerve Fibre Layer Thickness in hypertensives. [*J Indian Med Assoc* 2019; **117:** 14-7]

Key words **: Retina, RNFL, OCT.**

Retina is the innermost layer of the eyeball. It is a thin, delicate and transparent membrane.It is the most highly developed tissue of the eye[1]. The Retinal nerve fibre layer (RNFL) also known as the Stratum Opticum essentially consists of nonmyelinated axons of Ganglion cells which converge at the Optic nerve head, pass through the lamina cribrosa and is ensheathed by myelin posterior to the lamina. It is to be noted here that the ganglion cells form the second order neurons of the visual pathway. In addition to the axons of ganglion cells, the RNFL also contains the following :

- Centrifugal nerve fibres of unsettled origin and termination.
- Processes of Muller's cells (from the inner nuclear layer) which interweave with the axons of ganglion cells.
- Neuroglial cells.
- Retinal vessels in the form of a superficial capillary network.

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A healthy status of the RNFL is essential for proper maintenance of functional vision. Loss of this RNFL is essentially loss of ganglion cells of the retina resulting in drastic and irreversible effects on vision. It is to be noted in this regard that in Glaucoma, a form of optic neuropathy, there occurs optic nerve damage as evidenced by retinal nerve fibre layer defects. In West Bengal a population based study result showed the prevalence of glaucoma in above 50 year age group was found to be 3.4%[2]. Several studies conducted worldwide have identified certain risk factors for glaucoma[3-7], systemic hypertension being one of them. Whether this factor decreases the retinal Nerve Fibre Layer Thickness in apparently normal individuals is yet to be established. The present work aims to study various aspects of this presumed determinant, ie, systemic hypertension on the Retinal nerve fibre layer thickness in middle aged and elderly subjects of West Bengal and related risks of visual impairment associated with this factor.

Materials and Methods

Study Area :

Department of Anatomy, RG Kar Medical College and Hospital Kolkata and Regional Institute of Ophthalmology (RIO), Medical College, Kolkata 700073

Study Population :

Patients attending RIO out patients department with no posterior segment disorder and having a clear ocular

media were selected for the study.

Study Period :

One and half years approximately.

Sample Size :

Both eyes of 380 subjects of both sexes and aged above 40 years were examined and the results were recorded.

Sample Design :

In 380 Adults of both sexes and of various age groups, minimum age being above 40 years were chosen. It was made sure after careful evaluation that all of them were having a clear ocular media and none were having any posterior segment pathology. Systemic blood pressure in all of them was recorded and they were categorized as normotensives (less than 140/90 mm of Hg) or hypertensives (greater than 140/90 mm of Hg. Hypertensives were further categorized as Mild (SBP-140-159 mm Hg, DBP-90-99 mm Hg), Moderate (SBP-160-179 mmHg, DBP-100-109 mm Hg) and Severe (SBP>180 mm Hg DBP>110 mmHg) hypertensives..

Study Design :

Based on the above sample design, findings were recorded and a randomized Observational and cross-sectional study was undertaken to achieve the above objectives.

Parameters Studied :

(a) Peripapillary Fast RNFL thickness of both eyes.

(b) Systemic blood pressure.

Study Tools :

(a) Slit lamp biomicroscope, Direct and Indirect Ophthalmoscope for complete ophthalmic examinationwith dilated pupils to rule out any posterior segment pathology andexclude presenceof hazy media (eg corneal opacity, lenticular opacity, vitreous opacity etc).

(b) Goldmann Applanation Tonometer to record intraocular pressure.'

(c) Goldmann gonioscopic mirror to visualize the anterior chamber angles of both eyes.

(d) Humphrey visual field analyzer.

(e) Stratus Optical Coherence Tomograph (OCT)[8,9] for RNFL thickness assessment.

Study Techniques :

Complete ocular examination with dilated pupils was undertaken to rule out posterior segment pathology and media opaciy. Assessment of refractive error was done. Intraocular pressure (IOP) was measured with Goldmann Applanation Tonometer on three successive occasions. Visual field analysis with Humphrey's visual field analyzer 30-2 program was recorded. Venous blood was sent for Post prandial blood sugar estimation. Peripapillary fast RNFL thickness scan (3.4) was done on both eyes with Stratus OCT machine. The data thus collected in Regional Institute of Ophthalmology (RIO), Medical College, Kolkata was carefully studied and analysed in the department of Anatomy RG Kar Medical College, Kolkata to arrive at conclusions.

Inclusion Criteria :

- Best corrected visual acuity better than 6/9 for distance and N8 for near
- Vertical cup disc ratio (VCDR) $\leq$0.4
- IOP on three successive occasions less than 21 mm of Hg
- Anterior chamber angle open. (more than SHAFFER'S GRADE III)
- Visual field within normal limits. (By Humphrey's Visual Field analyser)
- Both normotensive and hypertensive subjects.

Exclusion Criteria :

- Best corrected visual acuity worse than 6/9 for distance and N8 for near
- Ocular media opacity.
- History of ocular surgery.
- Posterior segment pathology.
- Vertical cup disc ratio (VCDR) greater than 0.4
- IOP on three successive occasions greater than 21 mm of Hg .
- Anterior chamber angle closed.(Less than SHAFFER'S GRADE III)
- Diabetic (Postprandial blood sugar greater than 200 mg/dl)

Statistical Analysis :

The data thus collected was analysed statistically by using unpaired t test and correlation. SPSS V. 13.0 computer program was used for statistical analysis.

Observations

Results at a Glance :

- In the study population 57.89% were males and 42.11% were females .
- The age of the population was from 40 years to 81 years. Mean age of the study population was 54.89 years.
- The systolic blood pressure of the study population was 134.64±16.53 mm of Hg (Range-114 mm of Hg - 184 mm of Hg).
- The diastolic blood pressure of the study population was 85.95±9.39 mm of Hg (Range-70 mm of Hg-114 mm of Hg).
- Mean RNFL thickness of the study population was 101.62 ±10.42 μ
- Pearson correlation coefficient for the variation of systolic blood pressure *versus* RNFLthickness = -0.400, $p<0.0001$
- Pearson correlation coefficient for the variation of diastolic blood pressure *versus* RNFL thickness = -0.312, $p<0.0001$.

Blood Pressure Distribution of the Study Population :

Total study population : 380

Normotensives : 283

Hypertensives : 97 (25.52% of the study population. This is in accordance with the latest WHO Health statistics which states that 23.1% of adult males and 22.6 % of adult females are hypertensive in India.)[10] (Fig 3.1).

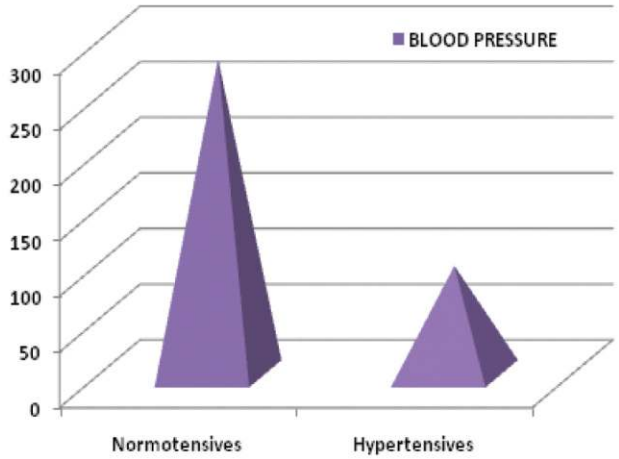

Fig 3.1 — Blood Pressure

Grades of Hypertension :

Grade	SBP (mm of Hg) (Systolic blood pressure)	DBP (mm of Hg) (Diastolic blood pressure)
Mild	140-159	90-99
Moderate	160-179	100-109
Severe	=180	=110
ISH*	>140	<90
*Isolated systolic hypertension		

Unpaired t test results to evaluate the statistical difference in RNFL thickness between Hypertensives versus Nonhypertensives

P value and statistical significance :

The two-tailed P value is less than 0.0001

By conventional criteria, this difference is considered to be extremely statistically significant.

Confidence interval :

The mean of Rnfl in Hypertensives minus Rnfl in Normotensives equals – 6.2337. 95% confidence interval(CI) of this difference: From -7.8790 to -4.5884.

Review of Data :

Group	RNFL in Hypertensives	RNFL in Normotensives
Mean	96.9797	103.2134
SD	7.4323	10.8197
SEM	0.5336	0.4548
N	194	566

Linear regression analysis of correlation between Systolic blood pressure *versus* RNFL Thickness In The Study Population

Pearson correlation coefficient = -0.40

statistical significance of r = -0.40 against 0

t= -12.01586; df= 758;

The two-tailed P value is less than 0.0001

By conventional criteria, this difference is considered to be extremely statistically significant (Fig 3.2).

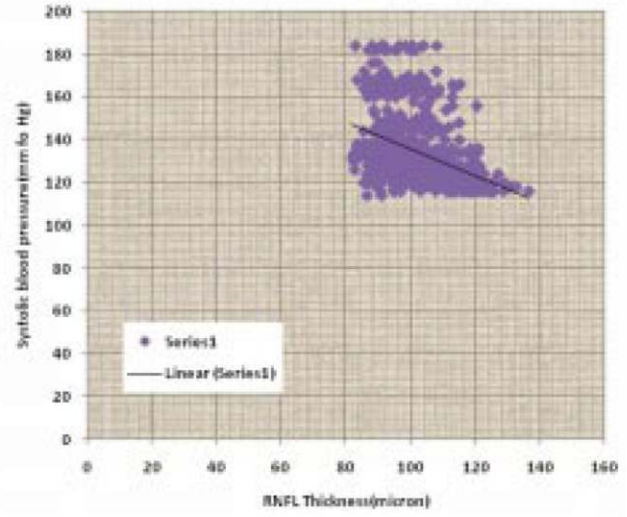

Fig 3.2 — Linear regression analysis of SBP versus RNFL

Linear regression analysis of correlation betweenDiastolic blood pressure Versus RNFL Thickness In The Study Population

Pearson correlation coefficient = -0.312

statistical significance of r= -0.312 against 0

t= -9.04124; df= 758; The two-tailed P value is less than 0.0001. By conventional criteria, this difference is considered to be extremely statistically significant (Fig 3.3).

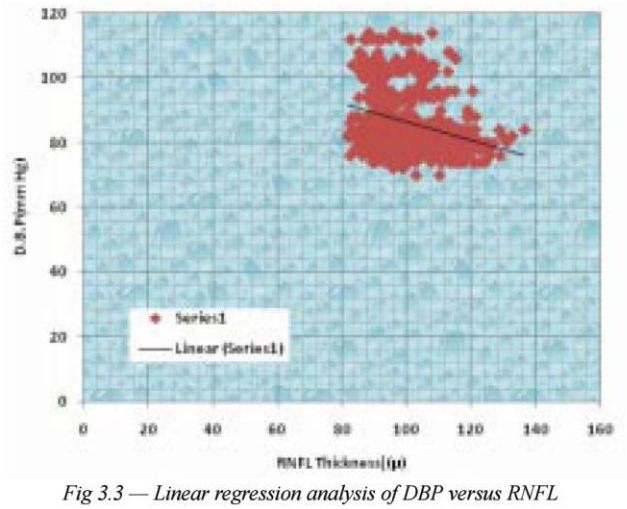

Fig 3.3 — Linear regression analysis of DBP versus RNFL

Discussion

Sony P, Sihota R, Tewari HK, *et al*[11], conducted a study to quantitatively assess the normative values for peripapillary retinal nerve fibre layer (RNFL) thickness with Optical Coherence Tomography (OCT 3) in Indian subjects. Parikh RS, *et al*[12], performed a similar study to determine the normal age-related loss of retinal nerve fiber layer thickness (RNFLT) as measured on Stratus optical coherence tomography in an Asian Indian population. R Ramakrishnan, *et al*[13], conducted a study to obtain retinal nerve fibre layer thickness measurements by optical coherence tomography (OCT) in normal Indian population. All these studies however did not evaluate systemic correlates on RNFL thickness. The Blue Mountains eye study[14] by Mitchell P, Lee AJ, *et al,* concluded that, hypertension was significantly associated with POAG, after adjustment for POAG risk factors, including IOP with an odds ratio (OR) 1.56 and 95% confidence interval (CI) 1.01–2.40. This relation was strongest in subjects with poorly controlled hypertension (POAG prevalence 5.4%), compared with normotensive subjects (POAG prevalence 1.9%), independent of IOP (OR 1.88, CI 1.09–3.25). The population-attributable risk for hypertension (20.4%) was higher than for other identified POAG risk factors.. Hypertension, particularly if poorly controlled, appears related to a modest, increased risk of POAG, independent of the effect of BP on IOP and other glaucoma risk factors. Bhojwani Krishna *et al*[15] conducted a study on central Indians,with the aim to determine the systemic correlates of RNFL thickness.They concluded that systolic blood pressure was negatively correlated with RNFL thickness (r -0.107 $p<0.001$). This study however showed no statistically significant relation between diastolic blood pressure and RNFL thickness.

In this regard it can be noted that Tien Yin Wong, *et al*[16], conducted a study to describe the cross-sectional relationship between retinal arteriolar and venular diameters with age and blood pressure, retinal arteriolar diameters were found to be decreased by by 4.4 µm (95% CI, 3.8–5.0) for each 10-mm Hg increase in mean arterial BP. The association of narrowed retinal arterioles and higher BP was stronger in younger persons. For each 10-mm Hg increase in mean arterial BP, arteriolar diameters decreased by 7.0 µm in persons aged 43 to 54 years but by only 2.5 µm in persons aged 75 to 84 years. The present study results are comparable to the findings of Bhojwani Krishna, *et al*, who found a negative correlation between RNFLT and systolic blood pressure (r=-0.107 $p<0.001$), just like us (r=-0.400 $p<0.0001$) only that the correlation was stronger in our case. They did not find any statistically significant correlation between diastolic blood pressure and RNFLT (p=0.407) but the present study found a statistically significant correlation (r=-0.312 $p<0.0001$). Hence it can be stated with some confidence that our study corroborates well with the Blue Mountain Eye Study although their studies were primarily based on glaucomatous patients and ours on normal subjects. So it is our recommendation that hypertensives, specially moderate to severe ones should have mandatory glaucoma evaluation and workout, more so if they are in the middle aged or elderly age group , irrespective of their gender.

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