Research Article

Effect of myopia on thickness of retinal nerve fiber layer as measured by optical coherence tomography

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Abstract

Background: Myopia is associated with a large eyeball in which collimated light produces a focussed image in front of the retina. This study was done to evaluate the relationship of foveal thickness and peripapillary RNFL thickness with myopia in eyes with no other obvious ocular pathology. **Methods:** Visual Field Analysis was done using static, automated, white-on white threshold perimetry (programme 24-2, Humphrey Field Analyser II, Carl Zeiss Meditec) and Retinal Nerve Fibre Layer Analysis of peripapillary nerve fibre layer and fovea, in dilated pupils, using OCT version 3 (Stratus OCT, Carl Zeiss Meditec Inc.). **Results:** In total 100 (62 males) myopic subjects were recruited for the study. The degree of myopia was not related with sex, age and foveal thickness of the individuals. The peripapillary retinal nerve fibre layer thickness of superior, inferior, nasal quadrant was significantly different in two groups of high myopic and low-to-moderate myopic group. The average thickness of RNFL was significantly less in high myopic when compared with low-to-moderate myopic group. The RNFL thickness was more in temporal quadrant of high myopic group. The superior, inferior, nasal and average RNFL thickness decreased with negative spherical equivalent. **Conclusion:** It can be concluded that the thickness of the peripapillary retinal nerve fibre layer decreases as the myopia advances in at least superior, inferior and nasal quadrants.
Keywords: RNFL.

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Received Date: 24/06/2015 Revised Date: 02/07/2015 Accepted Date: 05/07/2015

Access this article online

Quick Response Code:

Website: www.statperson.com

DOI: 07 July 2015

INTRODUCTION

The global prevalence of refractive errors varies from 80 million to 2.3 billion. Myopia is associated with a large eyeball in which collimated light produces a focussed image in front of the retina. The histopathological changes that accompany myopia include spiral thinning, posterior staphyloma, Fuch's spot, chorioretinal atrophy, large irregular tilted optic disc, myopic crescent, thin lamina cribrosa and localised retinal nerve fibre layer (RNFL) defects. Myopic eyes are at a 2-3 times greater risk of developing glaucoma than emmetropic eyes, The risk is independent of other risk factors like high intra ocular pressure (IOP). Patients with glaucoma can lose upto 40% of their RNFL before any visual field defect becomes evident. This emphasises the need to detect changes in RNFL accurately at an early stage. Since its introduction in 1991, Optical Coherence Tomography (OCT) has become the most convenient methods for assessment of peripapillary nerve fibre layer thickness. Although the thinning of the RNFL is indicative of glaucoma, it is unclear whether RNFL thickness varies with the refractive status of the eye. This study was done to evaluate the relationship of foveal thickness and peripapillary RNFL thickness with myopia in eyes with no other obvious ocular pathology.

MATERIAL AND METHODS

Subjects

The study was conducted in the Regional Institute of Ophthalmology, Kolkata from April 2008 to March 2009.

How to site this article: Atanu Biswas, Mahuya Pal Chattopadhyay, Ritesh Singh, Asim Ghosh. Effect of myopia on thickness of retinal nerve fiber layer as measured by optical coherence tomography. *International Journal of Recent Trends in Science and Technology*. July 2015; 15(3): 587-591 http://www.statperson.com (accessed 09 July 2015).

Both male and female adult myopic patients attending the Out Patient Department (OPD) of Ophthalmology Clinic were invited for enrolment in the study. They were enrolled after giving written informed consent and provided they met the inclusion criteria. The inclusion criteria to be included in the study were: myopia (spherical equivalent -0.5 to < -6.0 D in low to moderate myopia group and ≥ -6.0D in the high myopia group), best corrected visual acuity of at least 20/40, and no concurrent eye disease. The exclusion criteria were: clinical evidence of primary open angle glaucoma, myopic macular degeneration, peripapillary atrophy extending > 1.7 mm (the radius of the OCT RNFL scan) from the centre of the disc, intraocular pressure > 21 mm Hg, repeatable visual field defects, history of intraocular surgery, refractive surgery, neuro ophthalmic diseases or diabetes mellitus. Of the 120 eyes initially enrolled, 15 eyes were excluded because of presence of extensive peripapillary atrophy and 5 eyes were excluded because of presence of repeatable visual field defects. So, 100 eyes were included in the analysis. The approval from Institutional Ethics Committee was taken prior to initiation of the study.

Investigations

All enrolled patients underwent full ophthalmic examination including visual acuity, refraction, intraocular pressure measurement with Goldmann Applanation Tonometry, dilated fundus examination with stereoscopic bio microscopy of the optic nerve head under the Slit Lamp using +90D lens, Indirect Ophthalmoscopy, Visual Field Analysis using static, automated , white-on white threshold perimetry (programme 24-2, Humphrey Field Analyser II, Carl Zeiss Meditec) and Retinal Nerve Fibre Layer Analysis of peripapillary nerve fibre layer and fovea, in dilated pupils, using OCT version 3 (Stratus OCT, Carl Zeiss Meditec Inc.).

Statistical analysis

Statistical analyses were done with SPSS (Version 22.0; IBM SPSS, Chicago). The total average and quadrant-wise RNFL measurements between low-to-moderate and high myopia groups were compared by using independent t-test. Correlations between RNFL thicknesses and refractive error were examined by linear regression analysis and expressed as the Pearson coefficient of correlation (r). Two-tailed significance test with p value of 0.05 or less was considered to be statistically significant.

RESULTS

In total 100 (62 males) myopic subjects were recruited for the study. The mean (SD) age of the individuals was 26.9 (8.5) years. The best corrected visual acuity was 20/20 for 61 individuals. It was 20/30 for 23 individuals. The mean (SD) spherical equivalent (SE) of refractive errors was -8.621 D (6.226 D). The range of SE was -1.00 to -23.00 D. There were 40 low to moderate myopic (mean, SD and range SE: -2.825 D, 1.714 D and -1.00 D to -6.00 D) and 60 high myopic (mean, SD and range SE: -12.491 D, 5.01 D and -6.50 D to -23.00 D). The degree of myopia was not related with sex, age and foveal thickness of the individuals. The mean SE of refractive error was significantly different in the two groups (table 1). The peripapillary retinal nerve fibre layer thickness of superior, inferior, nasal quadrant was significantly different in two groups. The average thickness of RNFL was significantly less in high myopic when compared with low-to-moderate myopic group (table 2). The RNFL thickness was more in temporal quadrant of high myopic group. The superior, inferior, nasal and average RNFL thickness decreased with negative spherical equivalent with coefficients of correlation of.543, .568, .441 and .579 (all p value <.001) (table 3 and figures 1, 2, 3 and 5). It was not related with temporal RNFL thickness (figure 4).

Table 1: Characteristics of low-to-moderate and high myopic patients

	Low to moderate myopia	High myopia	p value
Mean (SD) age (years)	27.63 (9.59)	26.42 (7.82)	.491[#]
Sex (Male/Female)	24/16	38/22	.834[*]
Mean (SD) spherical equivalent (dioptres)	-2.825 (1.714)	-12.491 (5.01)	.000[#]
Mean (SD) Foveal thickness (mm)	194 (39.6)	179.9 (42.38)	.094[#]

[#]By independent t- test; [*] by chi square test

Table 2: Peripapillary Retinal nerve fibre layer thickness in low to moderate and high myopia groups as measured with optical coherence tomography (n=100)

Quadrant	Mean (SD) Retinal nerve fibre layer thickness (µm)		p value (by t- test)
	low to moderate (n=40)	High myopia (n=60)	
Temporal quadrant	73.35 (18.36)	77.12 (30.30)	.483
Superior quadrant	130.65 (26.86)	94.90 (35.00)	.000
Nasal quadrant	85.20 (29.83)	59.08 (29.34)	.000
Inferior quadrant	127.93 (26.59)	84.82 (39.47)	.000
Average RNFL thickness	105.71 (20.34)	78.98 (23.82)	.000

Table 3: Correlation between peripapillary retinal nerve fibre layer thicknesses at different quadrants and Spherical Equivalent

	Spherical Equivalent	
Quadrant	r	p value
Superior	.543	.000
Inferior	.568	.000
Nasal	.441	.000
Temporal	.079	.432
Average	.579	.000

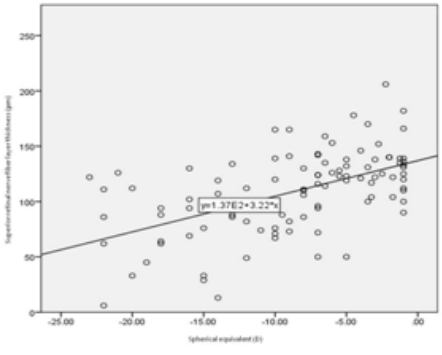

Figure 1

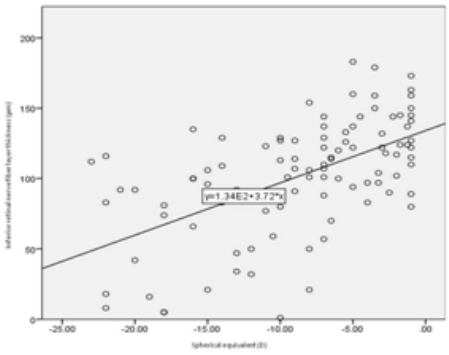

Figure 2

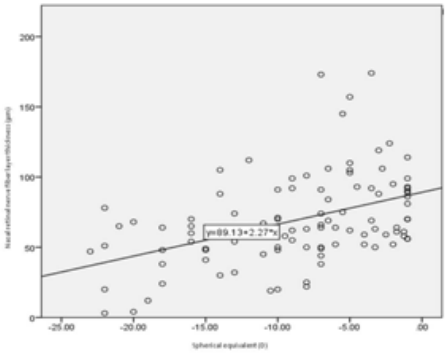

Figure 3

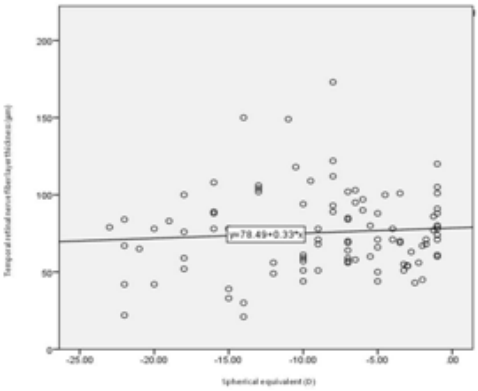

Figure 4

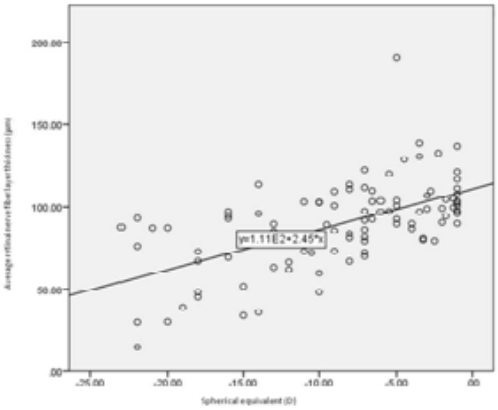

Figure 5

Legend

Figure 1: Scatter plots of the superior peripapillary retinal nerve fiber layer thickness and the spherical equivalent (r = 0.543, P = 0.000).
Figure 2: Scatter plots of the inferior peripapillary retinal nerve fiber layer thickness and the spherical equivalent (r = 0.568, P = 0.0001).
Figure 3: Scatter plots of the nasal retinal nerve fiber layer thickness and the spherical equivalent (r = 0.441, P = 0.0000).
Figure 4: Scatter plots of the temporal retinal nerve fiber layer thickness and the spherical equivalent (r = 0.079, P = 0.432)
Figure 5: Scatter plots of the average peripapillary retinal nerve fibre layer thickness and the spherical equivalent (r = 0.579, P = 0.000)

DISCUSSION

The study done at the referral eye hospital in eastern India shows that peripapillary retinal nerve fibre layer as measured by Stratus OCT is thinner in superior, inferior and nasal quadrant in high myopic individuals. The RNFL is thicker in temporal quadrant in high myopic when compared with low-to-moderate myopic individuals. In a study done by Kim *et al*[4] in Korea researcher divided 48 myopic subjects into three groups according to their spherical equivalent (SE): low myopia (-3.0 D<SE<0.0 D), moderate myopia (-6.0 D<SE</=-3.0 D) and high myopia (SE</=-6.0 D) groups and compared the RNFL thickness measured by Stratus OCT between the groups. The global average RNFL was significantly thinner in the high myopia group than in the low myopia group (107.4 (SD 7.6) vs 115.8 (8.5) μm, p = 0.029. For quadrant measures, the RNFL was thicker in the low myopia group than in the moderate and/or high myopia groups for the superior, nasal and inferior quadrants (all p values ≤ 0.020). However, the temporal quadrant was thinner in the low myopia group than in the moderate and high myopia groups (p = 0.001). We also found the temporal quadrant to be thinner (73.35 vs 77.12 μm) in the low to moderate group than high myopia group. However Öner V *et al*[5] found out that the RNFLs were thinner in superior, inferior and temporal quadrants (all p

< 0.05); whereas it was thicker in nasal quadrant (p < 0.05) of the myopics. Apart from the temporal clock hours, significant correlations were evident between RNFL measurements and the spherical equivalent in a study done by Leung CK *et al*[6]. They also found out that the average RNFL thickness decreased with negative refractive power (r = 0.291, P = 0.002). Kang SH *et al*[7] found out that myopia affected the RNFL thickness distribution as obtained with Cirrus HD OCT. According to them as the spherical equivalent decreased, the thickness of the temporal peripapillary RNFL increased and that of the superior, superior nasal, inferior, and inferior nasal peripapillary RNFL decreased. Mohammad Salih PA[8] investigated the influence of myopia on peripapillary retinal nerve fiber layer thickness using Cirrus optical coherence tomography in normal eyes. Ninety-eight eyes of normal participants with various degrees of myopia were recruited in this study. The RNFL thickness was measured with high-definition (HD), spectral-domain Cirrus OCT. The RNFL thickness was 119.2 ± 16.8 μm, 117.1±16.8 μm, 75.9±16.1 μm, and 64.9 ± 9.8 μm in the superior, inferior, temporal, and nasal quadrants, respectively, with an average thickness of 94.3 ± 8.6 μm. The mean RNFL thickness was thinner in highly and moderately myopic eyes (93 ± 7.9 μm and 92.6 ± 7.7 μm, respectively, P=0.0001) compared with low myopic eyes (102.2 ± 9 μm). A significant linear correlation was found between the spherical equivalent and the RNFL thickness in the superior (r=0.386, P=0.0001) and inferior quadrants (r=0.448, P=0.0001), and the average RNFL thickness (r=0.373, P=0.0001). The current study also found out linear correlation between the spherical equivalent and the RNFL thickness in superior, inferior and nasal quadrants and average RNFL thickness. In a study[9] done in children where mean age of the patients with high myopia was 7.8 years and that of low myopia was 7.2 years there was a significant difference in the overall RNFL thickness between the two groups (p < 0.05). Peripapillary RNFL thinning was especially prominent in the inferior quadrant in children with high myopia (p = 0.021). Sony P *et al*[10] in a study done in normal emmetropic eyes of Indians, found out that age had a significant negative correlation with average RNFL thickness (r = -0.321, P = 0.000) and with average superior (r = -0.233, P = 0.005) and average inferior RNFL thickness (r = -0.234, P = 0.004). There was no effect of gender on various RNFL thickness parameters. In the present study age was negatively associated with average RNFL thickness but it was not significant (r = -0.183, P = 0.069). The average RNFL thickness was not associated with gender in the present study. In a study done in Korea[11] investigators found out changes in the thickness of the fovea and peripapillary RNFL associated with myopia using the OCT. The data showed significant differences in fovea thickness between the groups. Huynh SC *et al*[12] found out that retinal nerve fiber layer thickness was least for the temporal quadrant (75.7+/-14.7 micron), followed by the nasal (81.7+/-19.6 micron), inferior (127.8+/-20.5 microm), and superior (129.5+/-20.6 micron) quadrants. Multivariate adjusted RNFL average thickness was marginally greater in boys than in girls (104.7 micron vs. 103.2 micron; P = 0.007). Zhao *et al*[13] found out that the RNFL thickness of superior, nasal, inferior and average sectors were decreased higher degree of myopia. In contrast, as the degree of myopia increased, the temporal sector thicknesses were increased. Rauscher FM *et al*[14] similarly found out no significant associations between RNFL thickness and age (P=0.20) and sex. Overall RNFL thickness decreased 3 μm/1 D sphere. The RNFL thickness had no significant relationship with sex or the age in another study[15]. In a study done by Wu PC *et al*[16] the mean retinal thickness in the inner and outer macular area (superior, nasal, inferior, or temporal) of the high myopia group was significantly less than in the non-myopia group. A study done in Chinese population[17] researchers found out that peripapillary retinal nerve fibre layer thicknesses from the superior, inferior and temporal quadrants were associated with spherical equivalents (all P < 0.01). It can be concluded that the thickness of the peripapillary retinal nerve fibre layer decreases as the myopia advances in at least superior, inferior and nasal quadrants. The average RNFL thickness also decreases but there is some thickening of the RNFL in the temporal quadrant. These facts need to be kept in mind while assessing peripapillary RNLF loss in diagnosis of Primary open angle Glaucoma in myopic individuals.

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Source of Support: None Declared
Conflict of Interest: None Declared