Original Article

Correlation of axial length and peripapillary retinal nerve fiber layer thickness measured by Cirrus HD optical coherence tomography in myopes

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Purpose: To evaluate the RNFL thickness by optical coherence tomography (OCT) and correlate it with the axial length and refractive error in myopes. **Methods:** Patients with myopia −1D to −10D attending ophthalmology OPD at a tertiary hospital from October 2013 to April 2015 for evaluation underwent ophthalmic examination including refraction, axial length, and OCT RNFL thickness measurements. The patients were divided into two groups; group A included patients with AL ≤24 mm and group B AL >24 mm. **Results**: The study included 100 eyes with myopia ranging from −1D to −10D. The mean (±SD) age was 26.87 (±5.93) years with a range of 21–48 years and male: female ratio of 2:3. There was a statistically significant difference in the average peripapillary RNFL thickness between the two axial length groups (P = 0.01); RNFL thickness in group A being 91.40 (±10.17) and group B 86.06 (±10.09); and in the average RNFL thickness between the 3 degrees of myopia groups, with higher myopic group having thinner RNFL (P = 0.001). **Conclusion:** There is a significant decrease in RNFL thickness with an increase in the grade of myopia and axial length. This polar RNFL thinning could be wrongly attributed to glaucomatous change. We recommend careful interpretation of RNFL data in myopes with axial length >24 mm, when applying the current OCT nomograms.

Key words: Axial length, myopia, RNFL thickness, OCT

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Myopia is considered to be a risk factor for open-angle glaucoma based on the findings of many studies.[1-3] However, myopia may be a confounding factor in the diagnosis of glaucoma.[2,4] Disc changes in myopes may make it difficult to distinguish glaucomatous optic neuropathy from the myopia-related optic nerve and retinal abnormalities that may complicate both the diagnosis and treatment of glaucomatous disease.[5,6] The presence of optic disc tilt and torsion along with peripapillary atrophy in myopic eyes makes detection of glaucomatous optic disc changes difficult.[7] Glaucoma diagnosis relies upon determining progressive optic nerve damage with corresponding visual field deterioration and peripapillary nerve fiber layer thinning.[8] Diagnosing glaucoma in the presence of optic nerve and retinal characteristics of moderate or high myopia is a unique challenge. Thus, it is imperative to understand the effects of high myopia on the RNFL thickness.[9-11] RNFL thinning associated with myopia may mimic the RNFL thinning associated with glaucoma, possibly leading to overdiagnosis. Variations in OCT RNFL thickness due to age and gender need to be considered too.

Currently, there is a growing prevalence of myopia in many regions of the world.[12,13] This will lead to an increase in the number of cases with a difficult diagnosis between RNFL changes due to myopia and glaucoma and deserves careful attention. The aim of this study is to evaluate the peripapillary retinal nerve fiber layer (RNFL) thickness by Cirrus HD optical coherence tomography (OCT) in myopia of all grades and correlate it with the axial length and severity of the refractive error.

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Methods

It is a cross-sectional study that included patients with myopia ranging between −1D and −10D attending ophthalmology OPD at a tertiary hospital from October 2013 to April 2015. Institutional ethics committee clearance and informed consent were obtained. A detailed history was taken along with a complete ophthalmological examination. The amount of refractive error was measured using Auto Refkeratometer RC 5000 and Retinoscopy. For the purpose of analysis, the patients were divided into three groups based on the degree of myopic refraction as follows: low myopia (<−3D), moderate myopia (−3D to −6D), and high myopia (>−6D).

A-scan ultrasound biometry was done by using Alcon-Ultrascan, software version- 3.00, for determining the axial length. Based on the axial length measured, the patients were assigned to two groups; group A with an axial length of ≤24 mm and group B with axial length >24 mm.

RNFL thickness was measured by a single operator using Cirrus HD Spectral Domain OCT (4000-1720) version-5.2.1.2. It was performed through a dilated pupil. External fixation was used and Optic disc cube 200*200 was obtained. Three of the best-obtained scans were selected. OCT was repeated when the scans obtained were not appropriate due to poor focusing

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or inadequate centration. The patients were excluded if repeat scans were also unsatisfactory. Finally, the selected OCT scans were analyzed using the average RNFL thickness program. Mean RNFL thickness was recorded globally and separately for the superior, inferior, nasal, and temporal quadrants.

Statistical analysis

First, the descriptive statistics were computed; for continuous variables mean with standard deviation and for categorical variables frequency counts with percentages were calculated. Inferential statistics was then done as follows: Pearson correlation was done when 2 continuous variables were correlated like RNFL thickness with age. The student t-test was applied when RNFL thickness of two groups was compared like Axial length grouping; one-way ANOVA was used when a categorical variable with >2 groups was correlated with RNFL thickness, like the degree of myopia.

Results

This study included 100 eyes of 50 patients with myopia ranging from −1D to −10D. The mean (±SD) age of the study population was 26.87 (±5.93) years with a range of 21–48 years. The study group had 40 males (40%) and 60 females (60%). Both, age and gender of the patient did not influence the RNFL thickness. The mean (±SD) refraction of the study population was -3.81 (±2.23) D with a range of −1 to −10D. The low myopia group (<−3D) had 46 eyes, moderate myopia (−3D to −6D) had 34 eyes, and high myopia (>−6D) had 20 eyes. The mean (±SD) axial length of the study population was 24.27 (±1.16) mm with a range of 22.15–28.75 mm. Group A (<24 mm) included 52 eyes and group B (>24 mm) included 48 eyes.

There was a statistically significant difference in the average peripapillary RNFL thickness between the two groups based on the axial length of the eye, with a mean (±SD) RNFL of group A being 91.40 (±10.17) and for the group B being 86.06 (±10.09) and $P = 0.01$. There was an inverse correlation between axial length and the RNFL thickness. The mean (+SD) peripapillary RNFL thickness of superior, inferior, and nasal quadrants showed a statistically significant difference ($P = 0.006$, $P = 0.03$ and $P = 0.01$, respectively), with increasing AL being associated with thinner RNFL thickness [Table 1]. However, the RNFL thickness of the temporal quadrant did not correlate significantly with axial length ($P = 0.75$). There was a statistically significant difference in the average RNFL thickness between the three degrees of myopia groups, with least myopia having higher RNFL thickness and high myopia with least RNFL thickness ($P = 0.001$); low myopia group mean RNFL being 92.17 (+9.84), moderate myopia group 88.12 (+9.53) and high myopia group 82.40 (+10.43). There was also a correlation between the degree of refractive error and the mean RNFL thickness along with superior, inferior, and nasal quadrants RNFL thickness ($P < 0.001$, $P = 0.005$, and $P = 0.027$, respectively). However, the RNFL thickness in the temporal quadrant ($P = 0.86$) did not correlate significantly with refraction [Table 2].

Discussion

This study was undertaken with the premise that moderate to high myopes may have a significant decrease in RNFL thickness that could place them outside the normal range, as defined by the OCT software. Various studies show conflicting data about the influence of myopia on peripapillary RNFL thickness.[14-18] A few studies showed that average RNFL thickness decreased with myopia and with an increase in the axial length.[10,11,14] They also showed that high myopes had thinner RNFLs than did low myopes and showed different topographic profiles, concluding that RNFL thickness is related to refractive error/axial length. Budenz *et al*. evaluated the determinants of normal RNFL thickness measured by stratus OCT and concluded that RNFL thickness varies significantly with optic disc area and axial length.[15] Even on using Cirrus OCT to measure RNFL thickness, Li Min Tai *et al*. reported that the average and inferior quadrant RNFL was thinner in highly myopic eyes compared to emmetropic eyes.[19] On the contrary, several studies did not find a significant correlation between myopia and RNFL thickness.[16-18]

Our study demonstrated that there was a statistically significant decrease in average RNFL thickness and also in the RNFL thickness of all the quadrants except in the temporal quadrant with an increase in the axial length and degree of refractive error. A similar conclusion was obtained in few other studies also.[10,20,21] In the study conducted by Rauscher

Table 1: Correlation of axial length with the retinal nerve fiber layer (RNFL) thickness

RNFL thickness	Groups	Number (n=100)	Mean (±SD)	t	P
Average	Group 1	52	91.40 (±10.17)	2.63	**0.01**
	Group 2	48	86.06 (±10.09)		
Superior	Group 1	52	120.94 (±17.81)	2.81	**0.006**
	Group 2	48	111.23 (±16.73)		
Inferior	Group 1	52	117.42 (±16.59)	2.16	**0.03**
	Group 2	48	109.94 (±18.05)		
Nasal	Group 1	52	66.52 (±9.83)	2.52	**0.01**
	Group 2	48	61.41 (±10.39)		
Temporal	Group 1	52	61.37 (±9.95)	-0.31	0.75
	Group 2	48	62.00 (±10.29)		

Table 2: Correlation of degree of myopic refractive error with the RNFL thickness

RNFL thickness	Refraction	Mean (±SD)	P
Average	Low	92.17 (±9.84)	**0.001**
	Moderate	88.12 (±9.53)	
	High	82.40 (±10.43)	
Superior	Low	122.24 (±16.99)	**<0.001**
	Moderate	116.53 (±15.75)	
	High	102.15 (±16.00)	
Inferior	Low	119.74 (±14.86)	**0.005**
	Moderate	110.32 (±16.58)	
	High	106.20 (±21.19)	
Nasal	Low	66.33 (±9.37)	**0.027**
	Moderate	64.06 (±11.59)	
	High	58.90 (±8.91)	
Temporal	Low	61.28 (±10.65)	0.862
	Moderate	61.56 (±7.29)	
	High	62.75 (±12.88)	

et al., there was no correlation between the RNFL thickness of the nasal quadrant with the axial length,[22] however, in our study, we found a significant decrease in RNFL thickness measurements even in the nasal quadrant.

Elongation and thinning of the sclera and the retina, which spread the nerve fibers over a larger surface area, could be the reason for thin RNFL in myopes. It could also represent a decrease in nerve fiber number, although there is no histological basis for it yet. Thus, thin RNFL measurements in moderate to high myopes appeared to be related to axial lengthening.

In the normative database for OCT, extremes of refractive error were excluded; hence, the current OCT normative data cannot be applied for higher refractive errors and should be interpreted with caution in moderate to high myopes. Importantly, thin polar RNFL could be wrongly attributed to glaucomatous change if one fails to take into account the effect of axial length.

Lastly, thin RNFL measurements in myopes could represent the cause for the overdiagnosis of glaucoma in these patients, which could partly explain why glaucoma has been shown to be more prevalent among myopes in few studies. Our study findings suggest that myopes undergoing RNFL analysis by OCT for glaucoma diagnosis should not be compared to age-matched normative data but to a normative control group that is matched for axial length and/or refractive error. We suggest a careful interpretation of RNFL data on moderate to high myopic individuals (particularly those with axial length >24 mm) when applying the currently available OCT nomograms.

Conclusion

In conclusion, peripapillary RNFL thickness measured with OCT is significantly thinner in patients with longer axial length and a higher degree of myopia. The clinical significance is that the thin polar RNFL in myopes could be wrongly interpreted as glaucomatous change if one fails to take into account the effect of axial length, by adjusting for it in the current OCT nomograms. We wish to highlight the importance of careful interpretation of RNFL data on moderate to high myopic individuals (particularly those with axial length > 24 mm).

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Conflicts of interest

There are no conflicts of interest.

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