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Original Research Article

Evaluation of peripapillary retinal nerve fiber layer thickness in myopia using spectral domain optical coherence tomography

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Abstract

Aims & Objective: To evaluate the correlation between peripapillary RNFL thickness and the severity of myopia. To determine the variations in peripapillary RNFL thickness with the age and duration of myopia using spectral domain optical coherence tomography.
Materials and Methods: Our study was a hospital-based observational cross-sectional study with 88 myopic patients between 18-40 years of age. The study included 88 eyes in each group (low myopia ≤ -3D and moderate to high myopia > -3D), and all subjects underwent a comprehensive ophthalmic examination. We evaluated the thickness of RNFL using SD-OCT in both groups in all quadrants. Data obtained was entered in the software Epi info version 7.2.1.0. and was analysed using SPSS software version 24.0. A paired t-test was used to compare mean changes in RNFL thickness between the low and moderate to high myopes. The association between the changes in RNFL thickness and other variables were assessed using the Chi-square test. A probability value (*P* value) < 0.05 is considered statistically significant.
Results: RNFL thickness was less in the moderate to high myopia group than in the low myopia group (*P* value- 0.000). In both the groups, RNFL thinning was observed with increasing duration of myopia (*P* value- 0.000). However, RNFL thinning with increasing age was observed only in the low myopia group (*P* value- 0.018). Glaucomatous changes were not appreciated in both groups.
Conclusion: The RNFL thickness varies with severity of myopia. The thinning of RNFL in myopes should not always be attributed to glaucoma.

Keywords: Myopia, Glaucoma, Optical coherence tomography, Retinal nerve fiber layer.

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1. Introduction

The purpose of the given study was to correlate the peripapillary RNFL thickness with the severity of myopia, age of the patient, duration of myopia.

Myopia is a public health concern worldwide. As per a World Health Organisation study - "The Impact of Myopia and High Myopia", in 2015, 1.84 billion people worldwide were myopes (27% of the world's population).[1] The incidence of myopia is increasing rapidly, and the numbers are estimated to rise to 52% by 2050. This increment in past years is due to computerisation and a lack of outdoor activities.[1]

Myopia is much more common in Asian countries than in Western countries.[2] The prevalence of refractive error in India is 53.1%, of which myopia was 27.2%.[3] Study done in the south Indian population, urban children and young adult showed the prevalence of myopia 29.8%.[4]

The RNFL (Retinal nerve fibre layer thickness) thickness is affected in various retinal pathologies like demyelinating diseases, neurodegenerative diseases, and glaucoma.[5]

Multiple studies have shown that measurement of extent of damage to RNFL is sensitive indicator of glaucoma.[6]

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Although RNFL thinning is indicative of glaucomatous damage, it remains uncertain whether RNFL thickness would vary with the refractive status of the eye. Hence, we planned to find a correlation between RNFL measurements and refractive error in myopia. The primary aim of the current study was "to correlate the peripapillary RNFL thickness with the severity of myopia". The secondary objective was "to corelate the peripapillary RNFL thickness with age and duration of myopia".

2. Materials and Methods

The cross-sectional observational study was carried out in a tertiary care medical college and hospital under the Department of Ophthalmology after the approval of the ethics and research committee (Ethics approval number: EC/07/2021). The sample size was calculated with 80% power and 95% confidence interval and mean thickness of RNFL in low myopes as 119.74µm and in moderate to high myopes as 110.32µm, using open-epi software version 3. The total sample size was 88 (44 in each group).[7]

Every alternate patient diagnosed with myopia between 18-40 years attending the ophthalmology OPD from February 2021 to April 2022 was included in this study. Patients were categorised based on degree of myopia into group A which included low myope (≤ -3D) and Group B which included moderate (> -3D to 6D) to high myope (> -6D).

Patients were enrolled in the study after obtaining valid written and informed consent. The patient's history regarding name, age, gender, occupation, previous ocular surgery, spectacles usage, use of contact lenses, duration of myopia and previous history of any ocular pathologies were noted. A thorough ocular examination was done, which included visual acuity using Snellen's chart for distant vision, which was converted into LogMAR value, and Jaeger chart for near vision; anterior segment examination was performed using slit lamp biomicroscope. They were made to undergo auto refractometer evaluation for refractive error values, and based on the values obtained, the subjective correction was given. IOP measurement was done using an applanation tonometer. In both eyes, pupillary dilatation was done with 1% Tropicamide. Post dilatation, retinoscopy was performed, followed by posterior segment examination using direct and indirect ophthalmoscope.

A Topcon SD-OCT (Spectral Domain-Ocular Coherence Tomography) was used to measure peripapillary RNFL thickness in each patient's eyes. The individual was made to sit comfortably in front of the SD-OCT machine and was asked to place his/her chin over the chin rest. Then was told to fixate one eye at a time at a green light through the lens. The iris was brought into view using a touch-driven alignment system. The optic disc cube 200x200 scan protocol was used to image the RNFL over the 6x6mm^2 peripapillary region.

The software's built-in algorithms identified the centre of the optic disc and a circle measuring 3.46mm in diameter were positioned automatically around the disc centre. This generates quadrant and clock-hour peripapillary RNFL measurements. Images with movement artefacts were repeated. The peripapillary RNFL parameters evaluated in this study consisted of superior, nasal, inferior, and temporal quadrant thickness. Two scans of each optic disc map were obtained, where both had a signal strength of more than 7 with good centration.

The data collected were documented in the case report form and were attached to the printout of the SD-OCT of optic disc RNFL for future reference.

2.1. Statistical analysis

Data obtained was entered in the software Epi info version 7.2.1.0 and was analysed using SPSS software version 24.0. Description of categorical variables like age was mentioned in mean and standard deviation. Gender, and duration of myopia were mentioned in percentages. Peripapillary RNFL thickness – superior, nasal, inferior, temporal and average were mentioned in mean and standard deviation. Paired t-test was used to compare mean changes in RNFL thickness between the low and moderate to high myopes. The association between the changes in RNFL thickness and other variables were assessed using the Chi-square test. A probability value (p-value < 0.05) is considered statistically significant.

3. Results

One seventy-six myopic eyes of 88 subjects were analysed and divided into two groups. Group A had 44 patients with low myopia, and Group B had 44 patients with moderate to high myopia. The demographics of the study population are given in **Table 1**. Gender distribution in both groups was similar.

Forty (90.9%) patients in group A and eight (38.6%) in group B had a duration of myopia of eight years or more (90.9%). Temporal rim [p value=0.001] and average RNFL thickness [p value=0.018] were significantly reduced in group A, in the age group 29 to 40 years, compared with 18 to 28 years.

Mean RNFL thickness decrease was seen in group A with advanced age. Amongst group B, there is no significant difference in RNFL thickness between this age group (**Table 2**). There was no significant difference in RNFL thickness among gender in both groups (**Table 3**). A significantly reduced average RNFL thickness in all quadrants was noted with increased severity of myopia in group B (**Table 4**).

A significantly thin RNFL was noted in both Group A and B, for those with duration of myopia for eight years or more (**Table 5**).

The **Table 6** presents the results of a multiple linear regression analysis to determine the factors affecting peripapillary retinal nerve fiber layer (RNFL) thickness in 88 participants, divided into Group A and Group B. In a multiple linear regression analysis involving 88 participants, age (18-28 years) showed a coefficient of -0.283 ± 0.191 with a p-value of 0.142, which was not statistically significant. The male gender coefficient was 0.195 ± 1.929 with a p-value of 0.920, also indicating no significant effect on RNFL thickness. However, those with 8 or more years of myopia showed a significant reduction in RNFL thickness (B = -9.039 ± 2.519, $p < 0.001$), highlighting a strong association between prolonged myopia and RNFL thinning.

Table 1: Demographics of study population

	Group A(n=44)	**Group B(n=44)**
Age		
18-28	36(81.8%)	36(81.8%)
29-40	8(18.2%)	8(18.2%)
Gender		
Male	27(61.4%)	24 (54.5%)
Female	17(38.6%)	20 (45.55%)
Duration of Myopia		
8 years or more	40(90.9%)	08(38.6%)
Less than eight years	04(9.1%)	27(61.4%)

n: Number of participants

Table 2: Comparison of RNFL thickness and age for group A and B groups

RNFL	**Group A: RNFL thickness in µm (mean ± SD)**		**p-value**	**Group B: RNFL thickness in µm (mean ± SD)**		**p-value**
	Age 18-28 in Years	Age 29-40 in Years		Age 18-28 in Years	29-40 in Years	
Inferior	136.1 ± 9.7	135.4±11.0	0.059	120.1± 12.5	117.7±15.1	0.132
Superior	133.7 ± 15.1	132.4±15.2	0.101	119.3± 22.6	120.9± 12.2	0.560
Nasal	86.6 ±12.4	85.7 ±11.8	0.877	75.3± 16.3	78.6 ±10.1	0.570
Temporal	79.8 ± 11.0	77.7 ± 11.3	0.001	70.6 ±11.8	64.2 ± 11.0	0.112
Average	109.3 ± 8.3	108.0 ± 8.9	0.018	96.6 ± 10.8	95.5± 9.8	0.154

RNFL: Retinal nerve fiber layer

Table 3: Comparison of RNFL thickness and Gender for group A and B groups

RNFL	**Group A: RNFL thickness in µm (mean ± SD)**		**p-value**	**Group B: RNFL thickness in µm (mean ± SD)**		**p-value**
	Males	Females		Males	Females	
Inferior	135.4 ± 11.0	135.6±10.8	0.721	120.2 + 12.1	119.1+ 13.7	0.790
Superior	132.4 ± 15.2	132.2±15.2	0.894	119.6 + 20.4	119.6+ 21.9	0.996
Nasal	85.7 ±11.8	85.1±13.0	0.686	74.6 + 15.7	77.0 + 15.2	0.611
Temporal	77.7± 11.3	77.9±11.4	0.865	66.6 + 6.5	71.8 + 14.6	0.147
Average	108.2 ± 10.1	107.9±8.2	0.910	95.3 + 10.3	97.4+ 10.9	0.513

RNFL: Retinal nerve fiber layer

Table 4: Comparison of RNFL thickness with severity of Myopia

RNFL	**Group A: RNFL thickness in µm (mean ± SD)**	**Group B: RNFL thickness in µm (mean ± SD)**	**p-value**
Inferior	135.4±11.0	119.6±12.8	0.00
Superior	132.4±15.2	119.6±21.0	0.00
Nasal	85.7±11.8	75.1±15.3	0.00
Temporal	77.7±11.3	69.5±11.8	0.001
Average	108.0±8.9	96.4±10.5	0.000

RNFL: Retinal nerve fiber layer

Table 5: Comparison of RNFL thickness and duration of myopia for group A and B groups

RNFL	Group A: RNFL thickness in µm (mean ± SD)		P value	Group B: RNFL thickness in µm (mean ± SD)		p-value
	Duration of myopia < 8 years	Duration of myopia ≥ 8 years		Duration of myopia < 8 years	Duration of myopia ≥ 8 years	
Inferior	137.1± 9.9	118.5 ±7.1	0.000	122.7 ±13.8	114.7 ±9.5	0.001
Superior	134.5 ± 14.2	112.1 ±8.8	0.000	125.8 ±12.9	109.8 ± 27.3	0.002
Nasal	86.4 ±12.1	79.5 ±6.0	0.008	78.9 ±11.2	71.2 ±19.7	0.060
Temporal	78.7 ±11.3	68.0 ±7.9	0.199	71.3 ±9.8	66.6 ±14.3	0.082
Average	109.4 ± 8.0	94.6 ±6.8	0.000	99.8 ±8.1	91.1±11.9	0.000

RNFL: Retinal nerve fiber layer

Table 6: Multiple linear regression analysis for the determinants of peripapillary RNFL thickness (N=88)

S. No	Variables	Group A- N (%)	Group B - N (%)	Linear Regression	
				B±SE (Confidence interval)	p-value
1.	**Age in years**				
	18-28	36(81.8%)	36(81.8%)	-0.283± 0.191 (-0.662, -0.0968)	0.142
	29-40	8(18.2%)	8(18.2%)		
2.	**Gender**				
	Male	27(61.4%)	24 (54.5%)	0.195± 1.929 (-3.641, 4.0321)	0.920
	Female	17(38.6%)	20 (45.55%)		
3.	**Duration of Myopia**				
	8 years or more	40(90.9%)	08(38.6%)	-9.039± 2.519 (-14.050, – 4.0279)	<0.001
	Less than 8years	04(9.1%)	27(61.4%)		

4. Discussion

In the current study, RNFL thickness was significantly lower in moderate-to-high myopia compared to low myopia across all quadrants.

Similar results were noted in a Philippines study where the average retinal nerve fiber layer thickness decreases as the refraction becomes more myopic.[8] A study done by Tai ELM et al found superior, inferior and nasal RNFL to be thinner in myopia groups compared to controls.[9] A significant decrease in RNFL thickness in patients with high myopia was found in all quadrants except in the temporal quadrant [p value= 0.001] in the study done by Porwal S et al.[7] In contrast, Biswas A et al. observed the temporal quadrant to be thinner [73.35 vs 77.12 µm] in the low to moderate myopes than the high myopes.[10]

The present study showed mean RNFL values in moderate to high myopes significantly thinner compared low myopes (p value - 0.000) (**Table 4**). An Indian study done noted the mean RNFL thickness to be thinner in high and moderate myopes when compared to low myopes and also found a linear correlation between spherical equivalent and RNFL thickness in superior and inferior quadrants.[10] Thinner RNFL measurements among moderate to high myopes compared to the low myope group in current study can be explained by axial lengthening. With elongation of eyeball in myopia there is thinning of the sclera with the retina, which spreads the nerve fibres over a larger surface area.[7]

Porwal S et al found RNFL thickness to be most negligible for the temporal quadrant, followed by the nasal, inferior, and superior quadrants which was similar to current study.[7] Another Korean study also found decreased RNFL thickness with increased myopia with nasal rim being thinnest. According to Kang SH et al, as the spherical equivalent decreased, the temporal peripapillary RNFL thickness increased, but the superior, superior nasal, inferior, and inferior nasal RNFL thickness decreased.[12] RNFL thinning in the superior and inferior quadrants is due to the structural weakness in the optic nerve head lamina cribrosa of these areas.[13]

The present study shows a significant decrease in RNFL thickness with increasing age in the low myopia group, which was not appreciated in the moderate to high myopia group (**Table 2**). Variable studies show a negative correlation between age and RNFL thickness.[14] A study done among Indian emmetropic eyes showed a negative correlation between age and RNFL thickness. A Hong Kong study showed reduction in RNFL thickness only at the age of 50 years or more.[15] But, in the current study, RNFL thickness is reduced in 29-40 years of the low myopia group compared to

the 18-28 years of the same group. Negative correlation in other studies may be due to the inclusion of a relatively young population and narrow age range. However, the regression analysis in present study revealed that age has no significant effect on RNFL thickness.

Our study showed a significant reduction in RNFL thickness with increasing duration of myopia (**Table 5**). Significant decrease in RNFL thickness was found in the inferior, superior, and nasal rim among group A with a duration of myopia for eight or more years. Similarly, group B, with eight or more years of myopia had a significantly decreased RNFL thickness at the inferior and superior rim. Mubashir et al also noted a decrease in mean RNFL thickness with increasing duration of myopia.[16] A Chinese study revealed a decreased RNFL thickness in the superior, temporal, and inferior quadrants with time, supporting our observation. However, the Chinese study involved the adolescent age group.[17]

In the present study, the RNFL thickness had no significant relationship with gender (**Table 3**). Like our study, Zha Y et al observed no significant association between gender and RNFL thickness.[18]

A study done among Pakistan's adult population revealed a significant RNFL thinning among male patients compared to the females.[16] However, in the current study gender is found to have no statistically significant association with RNFL thickness (**Table 6**).

Our OCT results are more accurate as we have used 3rd generation SD-OCT that facilitates high-resolution and high-speed RNFL imaging, which gives strength to our study. We considered only good quality scans with signal strength more than 7 for analysis.

The study had few limitations. We did not record the axial lengths of the eyes which is a crucial factor influencing RNFL thickness in myopia which could have given further insights into its the association with RNFL thickness. We did not have any control group (emmetropes). Furthermore, we did not include intraocular pressure recording and visual field testing (perimetry) in present study and hence, we could not assess corelation of glaucoma with RNFL loss.

5. Conclusions

The present study found significant reduction in the thickness of RNFL with increased severity of myopia. It supports the concept that RNFL thickness decreases with increasing age and duration of myopia.

6. Source of Funding

None.

7. Conflict of Interest

None.

8. Ethical Approval

Ethical No.: EC/07/2021.

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