ORIGINAL ARTICLE

Retinal Nerve Fiber Layer Thickness (RNFLT) in Myopic & Hypermetropic Eyes in a Subset of Pakistani Population

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ABSTRACT

Objective: This study aimed to evaluate retinal nerve fiber layer (RNFL) thickness in healthy individuals with myopic and hypermetropic eyes, using optical coherence tomography (OCT).

Study Design: A cross-sectional study.

Place and Duration of Study: The study was carried out at the Department of Ophthalmology, Dr. Akil bin Abdul Qadir Institute of Ophthalmology, Karachi, Pakistan from January 2015 to June 2015.

Methods: In this study, 300 eyes were included were examined using standard protocols by a single examiner. Subjects with a history of diabetic or hypertensive retinopathy, raised intraocular pressure (> 21mmHg), and previous intraocular or laser surgery were excluded from the study. The mean retinal nerve fiber layer thickness was calculated in both myopic and hypermetropic eyes.

Results: The mean global retinal nerve fiber layer thickness (RNFLT) in myopic eyes was found to be 93.98 ± 8.57 µm. In hypermetropic eyes, it was found to be 101.00 ± 6.58. This variation was found to be statistically significant with *p*-value of 0.001.

Conclusion: We concluded that individuals with myopic eyes had significantly reduced retinal nerve fiber layer thickness whereas those with hypermetropic eyes showed an insignificant increase in RNFLT compared to emmetropic eyes.

Keywords: *Hypermetropia, Myopia, Optical Coherence Tomography, Retina.*

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Introduction

Refraction refers to the bending of light rays while passing through one object to another. When the light rays pass through cornea and lens, they get refracted and the vision is produced. This refracted light gets focused on the inner most layer of eyeball i.e. Retina which converts the light-rays into signals that are sent via the optic nerve to the occipital lobe of cerebral cortex. The brain interprets these signals into the images that we see. Error in refraction occurs when the light does not get focused directly on retina. This could be due to the altered length of the eyeball, either shorter or longer, variations in the corneal shape, aging, or absence of the lens. Refractive error is of various types, but the most commonly occurring types are myopia & hypermetropia.

Hypermetropia is also known as far-sightedness, long-sightedness, or hyperopia. It is a condition in which distant objects are clearly seen, but near vision is blurred. This blur is due to inappropriate focus of light behind the retina. Myopia, which is also

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known as near-sightedness or short-sightedness, is a condition in which distant objects appear blurred whereas the near objects are clearly seen. Severe myopia is associated with an increased risk of cataracts, glaucoma and retinal detachment.[1]

The retina is the innermost sensory neural layer of the eyeball, lining its inner posterior surface. It has the choroid covering it externally, and internally, it faces the vitreous body. The retina is composed of ten layers, one of which is the retinal nerve fiber layer (RNFL). We can visualize these layers clearly under the microscope, but now it is possible to visualize them in vivo using Optical Coherence Tomography (OCT). OCT is a non-invasive imaging technology that provides high-resolution measurements of RNFL thickness, Optic Nerve Head (ONH) measurements, macular thickness etc.[2] OCT offers detailed understanding, accurate monitoring of disease progression and its response to different treatment modalities used for ophthalmic diseases especially chorioretinal diseases. This advancement has updated the ophthalmic practice over the period of last ten years. Further expansions in OCT are expected to be of greater help in quick assessment of diseases in more depth. Other than ophthalmology, OCT is also widely in the field of medicine.[3-5]

Several studies suggest that the RNFL and macular thickness are affected by a variety of factors like age, gender, race, error of refraction, positive family history of glaucoma, smoking, etc.[5-9] Therefore, these factors have to be given importance while assessing the RNFLT for any diagnosis. This can also be considered in evaluating individuals during their follow-up.

The objective of this study was to determine the relationship between refractive error and the RNFLT measured by Spectralis Heidelberg's Optical Coherence Tomography (OCT) in our population. Therefore, by relating the data obtained through this study, it will get easier for the clinicians to identify the individuals and follow them up to prevent retinal damage. It should be considered while evaluating retinal diseases, especially in patients with high refractive errors.

Methods

This cross-sectional study was carried out at the Department of Ophthalmology, Dr. Akil bin Abdul Qadir Institute of Ophthalmology, Karachi, Pakistan from January 2015 to June 2015 included 300 eyes from 150 individuals aged 40 years and above visiting an ophthalmic clinic in Karachi, Pakistan. The convenient sampling technique was used. The sample size was calculated using the WHO sample size calculator. Out of 300 eyes, 88 eyes were myopic, 77 were hypermetropic, and 135 were emmetropic. Ethical approval was taken from the ethical review committee of Dr. Ziauddin University, Karachi, Pakistan held on 17th December 2014 vide letter reference number: 0271214SMANA). Subjects with normal intraocular pressure (IOP) and cup disc ratio (CDR) < 0.4 were included in the study. Individuals with history of intraocular surgery or laser therapy, any ocular or specifically retinal pathologies, diseases such as MS or Parkinsonism etc., diabetic or hypertensive retinopathy and glaucoma were excluded from the study.

Initially an informed consent was obtained from all the subjects followed by detailed ophthalmic examination. The ophthalmic examination included testing for refractive error and visual acuity, slit-lamp biomicroscopy, C/D Ratio measurement by using direct ophthalmoscope and tonometry followed by OCT.

Refractive error was measured first by using automated refractor and then by Snellen's Chart by a single examiner.

OCT is a non-contact, non-invasive imaging modality that helps diagnosing a variety of diseases involving the eye. It provides quantitative measurements of retinal nerve fiber layer (RNFL), ONH and macular thickness parameters and can be used as a valuable tool in many intraocular surgeries.

In the medical field, optical techniques are of great importance because these are low cost and safe, offering good therapeutic prospective. Advancements in OCT technology have made it possible for its relevance in an extensive diversity of applications but its medical application is still dominating.

Spectralis Heidelberg's OCT testing was done by a single operator, after dilating the eyes with 1% tropicamide eye drops which produced cross sectional retinal images with defined macular margins. The predefined OCT software algorithm was used for identifying the anterior and posterior margins of RNFL, which helped in measuring the thickness in different sectors (nasal, temporal, superior, and inferior) to give an average measurement of RNFL globally. Every subject had RNFL thickness scans by fixing his/her gaze at the light source seen through the lens of OCT apparatus. The gaze fixation was to ensure proper positioning of the RNFL with respect to the ONH. After capturing few sequential OCT images, scanning was stopped and the RNFL position was tracked on OCT scan with respect to optic nerve

For statistical analysis, SPSS version 20 was used. Mean ± standard deviation was applied for quantitative variables. For qualitative variables, frequencies and percentages were used. Independent T test was used to assess the thickness variation with refractive errors. One-way ANOVA was used to find differences in between the groups. *p* value <0.05 was taken as significant.

Results

A total of 300 eyes from 150 individuals were included in this study, out of which 135 eyes were emmetropic (n=135), 88 eyes were myopic (n=88), and 77 eyes were hypermetropic (n=77). Mean age of the participants was 57.67 ± 11.42 years. We took values for the normal eyes of our population as a reference to compare the RNFL in myopic and hypermetropic eyes. Out of 88 myopic eyes, 48 eyes were males, whereas 40 eyes were females. From 77 hypermetropic eyes, 35 eyes were of males whereas 42 eyes were of females.

The mean global thickness of RNFL in emmetropic eyes was found to be 99.54 ± 8.96 µm; in myopic eyes, it was found to be 93.98 ± 8.57 µm, and in hypermetropic eyes, it was calculated to be 101.00 ± 6.58 µm. (Table 1).

Table 1: Mean global RNFL thickness in normal eyes having myopia and hypermetropia

Error of refraction	RNFL thickness Global average Mean ± S.D (µm)
Emmetropia (n = 135)	99.54 ± 8.96
Myopia (n = 88)	93.98 ± 8.57
Hypermetropia (n =77)	101.00 ± 6.58

n= no. of eyes

The thickness of RNFL in myopic eyes with emmetropic eyes was found to be significantly decreased with *p*value of 0.001 whereas in hypermetropic eyes, the RNFL thickness was insignificantly increased than emmetropic eyes with *p* value of 0.143. (Table 2).

Table 2: *P*-values in comparison to emmetropia, myopia & hypermetropia by One Way ANOVA followed by Tukey's test

Error of refraction	*P*-value
Emmetropia to Myopia	0.001*
Emmetropia to Hypermetropia	0.143
Myopia to Hypermetropia	0.001*

** highly significant*

Myopic eyes were found to have significantly reduced mean global RNFL thickness than hypermetropic eyes. (Figure 1a & 1b)

Mean RNFL thickness in each quadrant of optic disc was measured in both myopic and hypermetropic eyes. (Table 4) Figure 2a shows the optic nerve quadrants of one myopic eye. (Figure 2a). In hypermetropic eyes, the mean RNFL was found to be significantly increased compared to myopic eyes. All the quadrants were statistically different in both the groups except the temporal quadrant. Figure 2b shows the optic nerve quadrants of a hypermetropic eye. (Figure 2b) and (Table 3).

Discussion

We included 300 eyes in our study, out of which 135 eyes were emmetropic, 88 eyes were myopic, and 77 eyes were hypermetropic. We measured RNFL in normal eyes so that we can use it as reference to compare the RNFL in eyes with refractive errors (myopia hypermetropia).

Mean age of the participants included in our study was 57.67 ± 11.42 years. Normally, the aging process precedes ophthalmic problems. Therefore, we included those subjects who were 40 years and

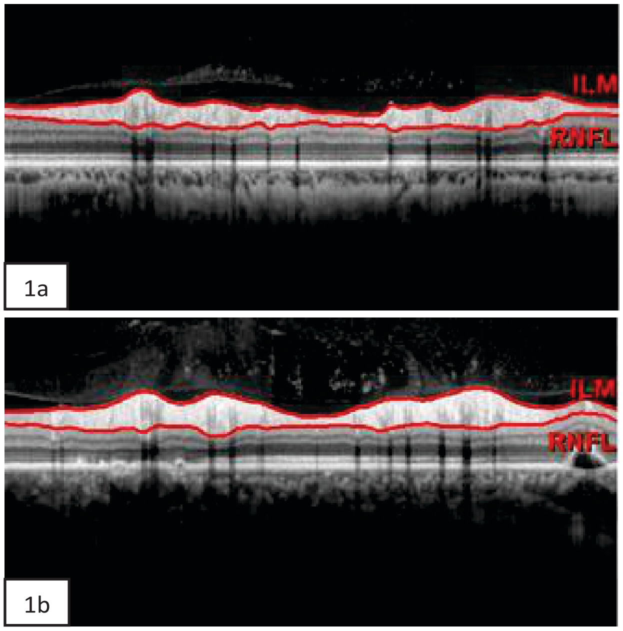

Fig 1: RNFL thickness analysis (from anterior margin to posterior margin of the RNFL layer) by using Spectralis software in (a) myopic eye and (b) hypermetropic eye

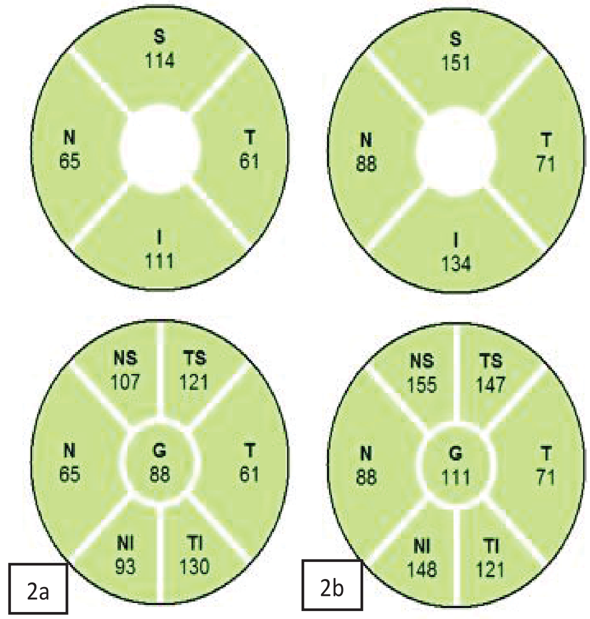

Fig 2: RNFL thickness in each quadrant of ONH in (a) myopic eye (b) hypermetropic eye by using OCT

Table 3: RNFL measurements in each quadrant of ONH in normal eyes having myopia and hypermetropia

Error of Refraction	ONH Quadrants Mean ± S.D. (μm)				
	Global	Inferior	Superior	Nasal	Temporal
Myopia (n=88)	93.99 ± 8.58	118.39 ± 18.41	115.49 ± 12.22	74.86 ± 12.46	66.01 ± 13.25
Hypermetropia (n=77)	101 ± 6.59	129.82 ± 12.57	125.62 ± 14.62	79.69 ± 12.44	68.74 ± 12.42
P value	0.001*	0.001*	0.001*	0.002**	0.061

**highly significant, **significant*

above. Hence, by relating the normal data obtained through this study, it will get easier for the clinicians to screen the high risk individuals prior to the onset of diseases involving the retina. It can also prove to be helpful during the follow up of individuals.

In this study, the RNFL thickness in each quadrant of ONH was measured in both myopic and hypermetropic eyes. Significant decrease in RNFL thickness of myopic eyes was noted favoring the fact that retinal thickness is affected by short sightedness. It is possible that the degree of elongation of the globe is likely to be related to the extent of retinal thinning leading to reflex stretching.[10,11] This is supported by Jonas et al. in their study done in 2020.[12] Many other studies also found the same effect of myopia on RNFL thickness.[11,13-16]

This study showed maximum RNFL thickness in inferior quadrant followed by superior quadrant, nasal quadrant and temporal quadrant. It is in accordance with ISNT rule which was established by Jonas et al. in Germany in 1999.[17] The ISNT rule is an easy way to remember how the optic nerve is supposed to look in a normal eye. Here "I" stands for inferior quadrant, "S" stands for superior quadrant, "N" stands for nasal quadrant and "T" stands for temporal quadrant. Normally the neuro-retinal rim is thinnest temporally and thickest inferiorly. Any deviation from ISNT rule will help the clinicians detect the optic nerve pathologies early. Even though the retinal thinning was noticed in myopic eyes, the ISNT rule was still followed. On the other hand, Qiu et al. in their study did not find the Retinal thickness following the ISNT rule and suggested that the ISNT rule has limited potential utility while diagnosing any retinal diseases.[18]

In our study, the RNFL thickness was found to be the least in measurement in nasal and temporal quadrants of ONH in myopic eyes. This could be due to the lack of large blood vessels and optic fibers making the retina at the periphery less resistant to traction and stretch, and this reduction in peripheral retinal thickness might balance the stretching force over the entire retina to safeguard the central retinal thickness. Milani et al. also stated in their study that the vascular density near macula is reduced in myopic eyes and associated with the spherical equivalent.[19] In an Egyptian study by Abdel et al. it was observed that peripheral retina is thinner in myopic eyes than the central retina.[20] This idea is supported by another study conducted by Choudhary et al. in 2021, concluding that in myopia, peripheral retinal thinning is more common than central retinal thinning.[21]

Salehi et al. in their meta-analysis of 47 studies in 2021 reported the RNFL thickness was found to be thicker in hypermetropic eyes than in myopic eyes.[22] In hypermetropia, the axial length decreases leading to decreased converging power of cornea and lens, resulting in a flattening of cornea, and increased thickness of lens and eyeball. Therefore, this could be the answer to the question of why the RNFL is much more affected in myopia than hypermetropia.

A Chinese study also proved the same effect of myopia on RNFL thickness parameters and suggested that myopia is known to be associated with a high risk of developing glaucoma high risk of developing glaucoma, so these factors are to be considered while identifying glaucomatous changes.[23] Another study commented that myopia predisposes individuals to various diseases such as cataracts, glaucoma, retinal detachment, and chorioretinal atrophy. Many genetic and proteomic studies will still discover the molecular involvement that explains the degenerative process that affects the retina.[24]

There are few studies that contradicted our results and commented that the association between the RNFL thickness and error of refraction is still debatable.[25] Xu et al., in their study, found out that the RNFL thickness in the temporal quadrant was increased in individuals with high myopia.[26]

The strength includes the use of a high-frequency spectral domain OCT and standardized examination techniques by a single trained technician. The limitations of the study include a relatively small sample size. However, this study provides baseline data on RNFL thickness measurements in myopic eyes of people residing in Karachi, Pakistan.

Conclusion

This study concludes that RNFL is significantly reduced in myopic eyes, whereas hypermetropic eyes showed insignificant thickening of RNFL when compared with emmetropic eyes. This refractive error is one of the significant factors in affecting the retinal thickness, which should be considered while evaluating retinal diseases such as diabetic retinopathy, glaucoma, and hypertensive retinopathy, especially in myopes.

Future Recommendations

Further studies can be planned to identify the extent of RNFL thinning with respect to per degree fall or rise in diopters of eye lenses. Future research can be conducted by using our results as a platform which can provide more detailed aspects of RNFL thickness in each quadrant of optic nerve concerning refractive errors.

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Authors Contribution

SM: Idea conception, study designing, data collection, data analysis, results and interpretation, manuscript writing and proof reading
NH: Idea conception
ML: Data collection
UF: Manuscript writing
SS: Data analysis
IR: results and interpretation