WILEY'S

International Journal of Pediatrics and Neonatal Health

ISSN 2572-4355

Research Article Open Access

Effect of Refractive Status and Axial Length on Retinal Nerve Fiber Layer Thickness Using OCT

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Citation: Fahmy RM (2017), Effect of Refractive Status and Axial Length on Retinal Nerve Fiber Layer Thickness Using OCT. Int J Ped & Neo Heal. 1:3, 88-95. DOI: 10.25141/2572-4355-2017-3.0091

Received: June 06, 2017; **Accepted:** June 17, 2017; **Published:** July 06, 2017

Abstract:

Aim of work

To evaluate the effect of refractive status and axial length of the eye on retinal nerve fiber layer (RNFL) thickness.

Method

A total of 116 eyes of 62 subjects were enrolled in the study. RNFL thickness was measured using TOPCON 3D OCT 2000.

Results

Hyperopic group, as compared to normal, did not show any significant thickening for average, superior, inferior, nasal, and temporal quadrants ($p = 0.760$, $p = 0.160$, $p = 0.139$, $p = 0.345$, $p = 0.762$, respectively). Also myopic group, as compared to normal, did not show any significant thinning for average, superior, inferior, nasal, and temporal quadrant ($p = 0.991$, $p = 0.746$, $p = 0.848$ $p = 0.382$, $p = 0.894$, respectively). The RNFL thickness decreased with increasing axial length and this was statistically significant in average, superior, inferior, and nasal quadrants ($p = 0.0009$***, $p = 0.0003$***, $p = 0.0031$**, $p = 0.0129$**, respectively), except for temporal quadrant ($p = 0.8118$).

Conclusion

Neither hyperopia nor myopia affect retinal nerve fiber layer thickness significantly.

The RNFL thickness decreased with increasing axial length and this was statistically significant in average, superior, inferior, and nasal quadrants except for temporal quadrant

Keywords: Emmetropia, Hyperopia, Myopia, RNFL, 3D OCT

Introduction

Previous studies using time domain (TD) OCT have shown that RNFL thickness measurements could be influenced by refractive status and the axial length of the eye (Leung et al., 2005). These variables should be taken into account to make more clinically useful normative databases of peripapillary RNFL thickness.

Optical coherence tomography (OCT) has been shown to be valuable in the diagnosis and monitoring of retinal diseases and glaucoma (Wollstein et al., 2004; Giovannini et al., 2002; Greenfield et al., 2003; Guedes et al., 2003; Lederer et al., 2003; Leung et al., 2005; Medeiros et al., 2005), it enables objective measurement of the optic nerve head, RNFL and macular thickness parameters (Hougaard et al., 2007; Nouri et al., 2008).

Subjects and methods

A total of 116 eyes of 62 female students and employee from King Saud University Female Campus, comprising 40 emmetropic eyes of 20 subjects (+0.5 to -0.5 DS), 36 hyperopic eyes of 22 subjects (+0.75 and above), 40 myopic eyes of 20 subjects (-0.75 and above) in the age group of 20 to 46 years were enrolled in this cross sectional study. Patients with astigmatism higher than 1.00 D, amblyopia, strabismus, glaucoma, retinal and optic disc anomalies or any systemic diseases with ocular complications were excluded.

All subjects underwent detailed clinical examination including the following: 1. Measurement of refractive error using Auto Refractometer. 2. Visual acuity by Snellen chart. 3. Slit lamp examination. 4. Goldmann applanation tonometry. 5. Fundoscopy. 6. Axial length measurement using IOLMaster.

7. Retinal nerve fiber layer analysis of both eyes (without dilatation) using 3D OCT-2000 Spectral Domain OCT.

Results

Statistical analysis

Statistical analysis was performed using a commercially available statistical software package (SPSS for windows, version 22). Both eyes were taken for the statistical analysis. Analysis of variance (ANOVA) has been used to find the significance of study parameters between three or more groups of patients. Student t-test was used for normally distributed variables. Pearson correlation analysis according to the distribution type of the variables was used to analyze relationships between variables. P-value less than or equal to 0.05 was considered statistically significant.

Results

In this study 116 eyes of 62 individuals (40 emmetropic eyes of 20 subjects, 36 hyperopic eyes of 22 subjects, and 40 myopic eyes of 20 subjects) underwent evaluation of retinal nerve fiber layer thickness in the age group of 20-46 years using 3D Spectral Domain OCT. Demographic details of which are given in Table 1. The mean age was 21.30 ± 1.63 (range: 20-25) years in emmetropic group, 23.19 ± 6.68 (range: 20-46) years in hyperopic group, and 21.10 ± 1.19 (range: 20-23) years in myopic group.

Age	Group I (Control)	Group II (Hyperopic)	Group III (Myopic)
20 - 22	14 (70%)	17 (77.27%)	16 (80%)
23 - 24	5 (25%)	2 (9.09%)	4 (20%)
>24	1 (5%)	3 (13.63%)	0

Table.1: Age distribution in the three groups studied

The retinal nerve fiber layer thickness results

There was no significant differences between the groups concerning age. In the hyperopic group, one patient had a visual acuity of 20/30 and the rest of patients in hyperopic group and all of the subjects in the myopic and emmetropic group had visual acuities of 20/20. The mean SE value in emmetropic, hyperopic, and myopic group were -0.30 ± 0.33, + 1.27 ± 1.02, and -3.05 ± 1.25 respectively. In all groups, mean astigmatism was less than 1.00 D. The Average RNFL thickness in normal group was 111.73±10.31microns. This was the reference thickness. In increasing myopia the RNFL thickness was seen to decrease and in increasing hypermetropia the RNFL thickness was increased (Table 2).

Parameters	Group I (n= 40)	Group II (n= 36)	Group III (n= 40)
AXL (mm)	23.43 ± 0.86	22.74 ± 0.67	24.47 ± 0.71
RNFL average (µm)	111.73 ± 10.31	117.00 ± 8.90	107.16 ± 8.46
RNFL superior (µm)	139.35 ± 14.02	148.69 ± 16.51	132.47 ± 16.20
RNFL inferior (µm)	143.95 ± 15.11	149.72 ± 14.67	139.10 ± 13.03
RNFL nasal (µm)	85.42 ± 14.46	89.94 ± 10.77	78.70 ± 14.44
RNFL temporal (µm)	78.18 ± 9.74	79.78 ± 9.51	76.70 ± 12.36

Table 2: Clinical parameters in various groups studied (mean ± SD).

RNFL, Retinal nerve fiber layer for per papillary region; AXL, Axial length.

Group I (control) had an average RNFL thickness of 111.73 ± 10.31µm and an average AXL of 23.43 ± 0.86 mm, Group II (hyperopic) had an average thickness of 117.00 ± 8.90 µm and an average AXL of 22.74 ± 0.67 mm, Group III (myopic) had an average RNFL thickness of 107.16 ± 8.46 µm and an average AXL of 24.47 ± 0.71 mm (Figure 1).

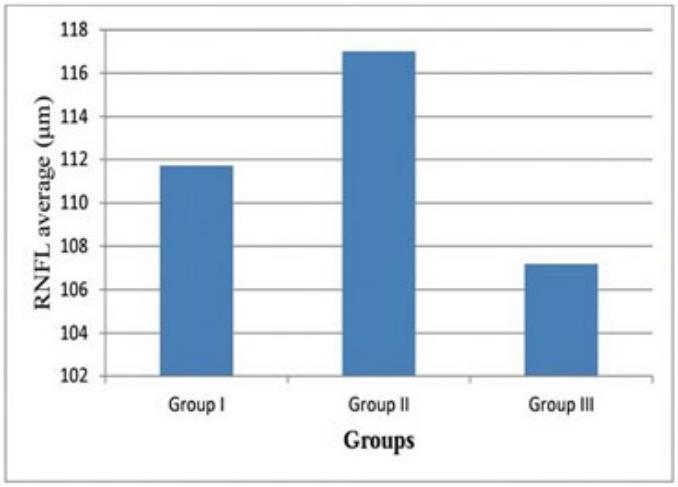


Fig.1: Average RNFL thickness in the various groups studied

Group II, as compared to normal, shows increase in average and all quadrants RNFL thickness, but this was insignificant for average, superior, inferior, nasal, and temporal quadrants (p = 0.760 , p = 0.160, p = 0.139, p = 0.345, p = 0.762, respectively).Group III, as compared to normal, shows thinning in the average and all quadrants RNFL thickness, but this was insignificant for average, superior, inferior, nasal, and temporal quadrant (p = 0.991, p = 0.746, p = 0.848 p = 0.382, p = 0.894, respectively) (Table 3).

Parame-ters	Group I (n= 40)	Group II (n= 36)	P- Value	Group III (n= 40)	P- Value
RNFL average (µm)	111.73 ± 10.31	117.00 ± 8.90	0.760	107.16 ± 8.46	0.991
RNFL superior (µm)	139.35 ± 14.02	148.69 ± 16.51	0.160	132.47 ± 16.20	0.746
RNFL inferior (µm)	143.95 ± 15.11	149.72 ± 14.67	0.139	139.10 ± 13.03	0.848
RNFL nasal (µm)	85.42 ± 14.46	89.94 ± 10.77	0.345	78.70 ± 14.44	0.382
RNFL temporal (µm)	78.18 ± 9.74	79.78 ± 9.51	0.762	76.70 ± 12.36	0.894

Table 3: Comparison of RNFL thickness in various groups studied.

Axial length and retinal nerve fiber layer thickness result

The RNFL thickness decreased with increasing axial length and this was statistically significant in average, superior, inferior, and nasal quadrants ($p = 0.0009^{***}$, $p = 0.0003^{***}$, $p = 0.0031^{**}$, $p = 0.0129^{**}$, respectively), except for temporal quadrant ($p = 0.8118$) (Figure 2/ Table 4).

	114.06 ±	144.22 ±	147.48 ±	86.86 ±	78.07 ±
21-23 mm					
	9.99	15.97	14.60	12.36	10.29
	107.17 ±	131.94 ±	138.62 ±	79.55 ±	78.61 ±
24-25 mm					
	8.44	14.13	12.09	15.36	11.12
P-value					
	0.0009***	0.0003***	0.0031**	0.0129**	0.8118

Table.4: Comparison of axial length and RNFL thickness.

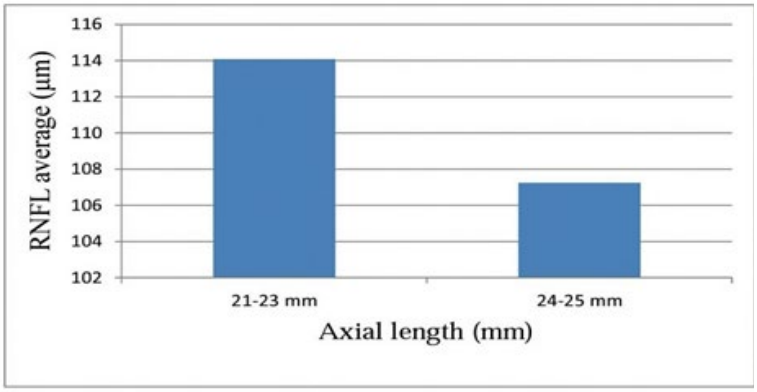


Fig.2: Average RNFL thickness in various axial lengths

Correlation between axial length and RNFL thickness

The mean RNFL thickness had a weak negative correlation with axial length (r = -0.379, p = 0.01**) (Figure 3/ Table 5).

Parameters	(Pearson correlation) r	P- Value
RNFL mean (µm)	-0.379	0.01**
RNFL superior (µm)	-0.392	0.01**
RNFL inferior (µm)	-0.363	0.01**
RNFL nasal (µm)	-0.365	0.01**
RNFL temporal (µm)	0.1284	0.170

Table. 5: Correlation between axial length and RNFL thickness

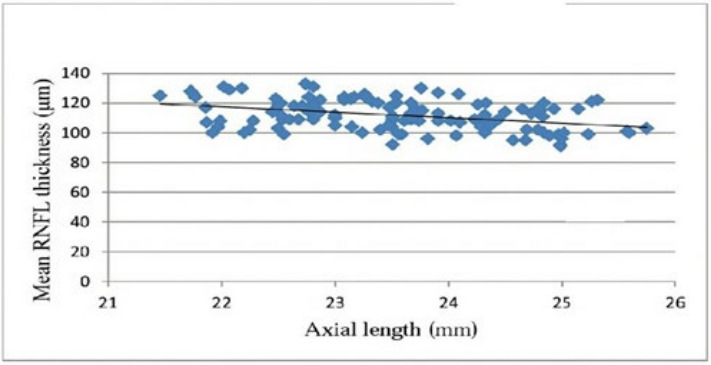
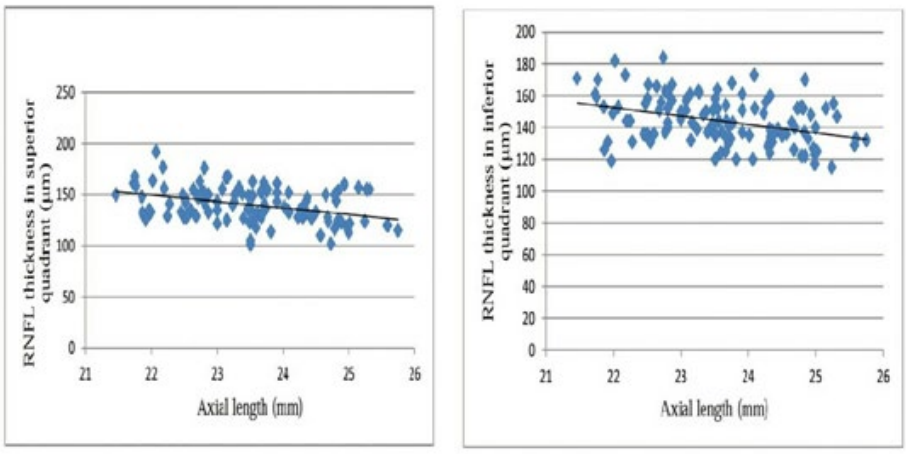


Fig.3: Correlation between axial length and mean RNFL thickness

RNFL thickness in superior, inferior, and nasal quadrants had weak negative correlations with axial length (r = -0.392, p = 0.01**; r = -0.363, p = 0.01**; r = -0.365, p = 0.01**,respectively), except for the temporal quadrant was positive and insignificant (r = 0.128, p = 0.170) (Figure 4, 5, 6,7/ Table 5).



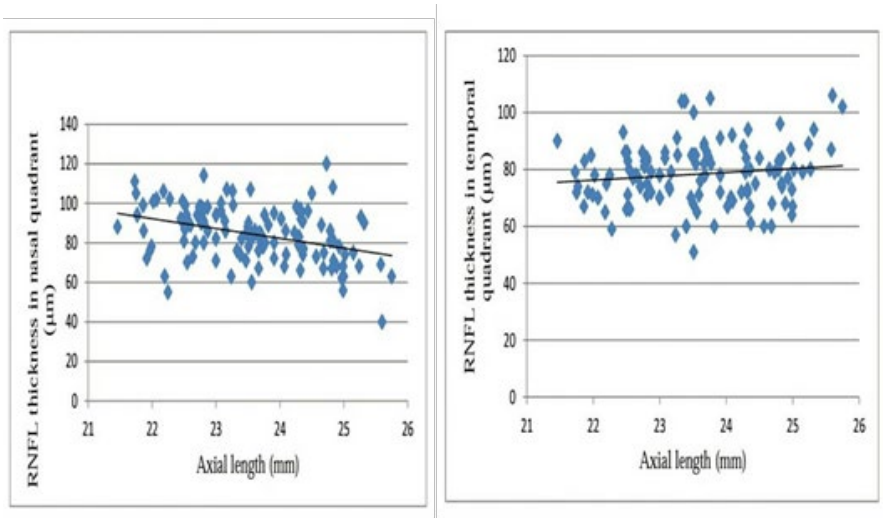


Figure.4,5,6,7: Correlation between axial length and RNFL thickness in four quadrants.

Spherical equivalent and retinal nerve fiber layer thickness results Hyperopic group

Parameters	(Pearson correlation) r	P- Value
RNFL mean (µm)	0.352	0.03*
RNFL superior (µm)	0.338	0.044*
RNFL inferior (µm)	0.339	0.043*
RNFL nasal (µm)	0.367	0.028*
RNFL temporal (µm)	- 0.184	0.284

Table 6: Correlation between spherical equivalent and RNFL thickness in hyperopic group.

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In the hyperopic group, mean RNFL thickness of the hyperopic group had a weak positive correlation with spherical equivalent (r = 0.352, p = 0.03*). RNFL thickness in superior, inferior, and nasal quadrants had weak positive correlations with spherical equivalent (r = 0.338, p = 0.044*; r = 0.339, p = 0.043*, r = 0.367, p = 0.028* respectively) , but temporal quadrant did not show any significant correlation with spherical equivalent (r = - 0.184, p = 0.284) (Table 6).

Myopic group

Parameters	(pearson correlation) r	P- Value
RNFL mean (µm)	0.111	0.496
RNFL superior (µm)	0.262	0.103
RNFL inferior (µm)	- 0.021	0.896
RNFL nasal (µm)	0.182	0.260
RNFL temporal (µm)	- 0.343	0.030*

Table 7: Correlation between spherical equivalent and RNFL thickness in myopic group.

In the myopic group, mean RNFL thickness of the myopic group did not show any significant correlation with spherical equivalent (r thickness (μm) = 0.111, p = 0.496). RNFL thickness in superior, inferior, and nasal quadrants did not show any significant correlations with spherical equivalent (r = 0.262, p = 0.103; r = - 0.021, p = 0.896; r = 0.182, p = 0.260, respectively) but temporal quadrant had a weak negative correlation with spherical equivalent (r = - 0.343, p = 0.030*) (Table 7).

Discussion

Our results show that RNFL thickness is not affected by the refractive error of the eye which is inconsistent with previous study outcome (Veysi Öner et al., 2012; Veysi Oner et al., 2013; Sowmya V. et al., 2015), this is because the study was enrolled in King Saud University Female Campus in three months duration which negatively affect the sample size and refractive error range. However, our result show that RNFL thickness decrease as axial length increase. the reduction was represented as a significant thinning in the RNFL of people with high axial length as it was verified by previous studies (Tariq et al., 2012; Christopher et al., 2006).

Veysi Öner et al. (2012), using SD OCT documented a significant reduction in the RNFL thickness in the inferior and temporal, but there is no significant differences in the superior and nasal quadrant of myopic group. He also documented a significant increase in the RNFL thickness in the inferior and temporal quadrant, but there is no significant differences in the superior or nasal RNFL thickness of hyperopic group.

Veysi Oner et al. (2013), using stratus OCT documented a significant reduction in the RNFL thickness in the superior, inferior, temporal, and nasal quadrant of myopic group. He also documented a significant increase in the RNFL thickness in the nasal quadrant and no significant differences in the superior, inferior, or temporal RNFL thickness of hyperopic group.

Our results showed that the RNFL thickness was negatively correlated with axial length in superior, inferior, and nasal quadrant except for the temporal quadrant (r = -0.392, p < 0.01; r = -0.363, p < 0.01; r =9

-0.365, p < 0.01; r = 0.128, p = 0.170, respectively), which is consistent with previous study outcome

(Christopher et al.2006).

Conclusion

Neither hyperopia nor myopia affect retinal nerve fiber layer thickness significantly. In the hyperopic group, mean RNFL thickness and RNFL thickness in superior, inferior, and nasal quadrants had weak positive correlations with spherical equivalent, but temporal quadrant did not show any significant correlation with spherical equivalent. In the myopic group, mean RNFL thickness and RNFL thickness in superior, inferior, and nasal quadrants did not show any significant correlation with spherical equivalent, but temporal quadrant had a weak negative correlation with spherical equivalent.

The RNFL thickness decreased with increasing axial length and this was statistically significant in average, superior, inferior, and nasal quadrants except for temporal quadrant. The mean RNFL thickness and RNFL thickness in superior, inferior, and nasal quadrants had weak negative correlations with axial length, except for the temporal quadrant was positive and insignificant.

Compliance with Ethical Standards

Conflict of Interest: I declare no potential conflicts of interest with respect to the authorship, and/or publication of this article.

Ethical approval: All procedures performed were in accordance with the ethical standards of the institutional research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent: Informed consent was obtained from all individual participants included in the study.

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