Med. J. Cairo Univ., Vol. 89, No. 4, September: 1651-1658, 2021
www.medicaljournalofcairouniversity.net

Evaluation of the Relationship between Retinal Nerve Fibres Layer (RNFL) Thickness in Myopia versus Hypermetropia

NEGM ELDIN H. ABD ALLAH, M.D.; LAMIA S. ELEWA, M.D.;
HAZEM M.O. MOHAMED RASHED, M.D. and ALSHIMAA A.S. ELSROUGY, M.Sc.

The Department of Ophthalmology, Faculty of Medicine, Ain Shams University

Abstract

Background: OCT has evolved over the past decade as one of the most important ancillary tests in ophthalmic practice. OCT makes it possible to obtain noninvasive, rapid, objective, high-resolution, cross-sectional imaging of the retina, the (RNFL) and the optic nerve head and also permits direct, real-time imaging of ocular pathology that previously could not be visualized using traditional methods.

Aim of Study: The purpose of this study is to evaluate the relationship between retinal nerve fiber layer thickness (RNFL) in myopia versus hypermetropia.

Patients and Methods: A comparative study included a total of 68 eyes divided into 45 eyes with errors of refraction and 23 emmetropic eyes in the period from March 2020 to September 2020 (Myopic eyes above -4 D, hypermetropic eyes above +4D).

Results: The results found in our study showed that there was statistically significant difference in RNFL thickness between myopic eyes, hypermetropic eyes in comparison to emmetropic eyes. RNFL thickness decreases in myopic eyes in the whole thickness and in all quadrants except in temporal quadrant, while RNFL thickness increases in hypermetropic eyes in the whole thickness and in all quadrants except in temporal quadrant.

Conclusion: Our study is comparing the peripapillary RNFL thicknesses of myopic eyes versus hyperopic eyes. We have shown that peripapillary RNFL thickness differed with refractive status of the eye being thinner in myopic eyes and thicker in hyperopic eyes.

Key Words: *Retinal nerve fibres layer – Myopia – Hypermetropia.*

Introduction

VARIOUS methods are being used to assess and image the retinal nerve fiber layer (RNFL), including fundus photography, scanning laser polarimetry, Heidelberger retinal tomography (HRT) and optical coherence tomography (OCT) [1].

Correspondence to: Dr. Alshimaa A.S. Elsrougy,
E-Mail: Alshimaa.adel.salaheldin@gmail.com

The OCT is a modern non-invasive imaging method which measures the peripapillary RNFL thickness in all quadrants in noncontact manner [2]. The latest spectral domain optical coherence tomography (SD-OCT) provides high axial scanning resolution (10um) which makes RNFL measurements reliable and reproducible.

Age, gender, ethnicity, axial length, size of the optic disc and refractive status of the eye are different factors which have been reported to affect the RNFL thickness [3].

The relationship of the RNFL thickness with refractive error has been extensively investigated in adults [4] and in children [4]. Different studies have shown racial differences in RNFL thickness [5].

It is therefore important to investigate whether any correlation exists between RNFL measurements and the refractive error in our population.

The current study is planned to determine the relationship between refractive error and the RNFL thickness measured by OCT in our clinical setting.

Aim of the work:

The purpose of this study is to evaluate the relationship between retinal nerve fiber layer thickness (RNFL) in myopia versus hypermetropia.

Patients and Methods

A comparative study was conducted at Ain Shams University Hospital between March 2020 to September 2020 following the approval of the research ethical committee of Ain-Shams University. 45 Eyes with errors of refraction and 23 emmetropic eyes divided into 3 groups: Group A: Myopic (above -4 D), Group B: Hypermetropic.

(above +4D) and Group C: Emmetropic were enrolled in the study and consent form was explained to all participants and signed a written consent. Inclusion Criteria were; (1) Willingness to participate; (2) Subjects 18 years old and above will be included and divided into 3 groups: 18-30 years, 30-40 years, Above 40 years; (3) Clear optical media. Exclusion Criteria were; (1) Presence of ocular pathology; (2) Any medical disease prevents patients from positioning on the device; (3) Eyes with amblyopia; (4) History of ocular trauma; (5) Glaucoma and previous laser; or (6) Retinal therapy.

All patients were subjected to Medical & ophthalmic history taking followed with a complete ophthalmological examination. Visual acuity: Uncorrected VA (UCVA) & best corrected VA (BCVA) using snellen charts was examined.

All patients underwent examination of anterior segment then Fundus examination using slit lamp biomicroscopy (TOPCON series number 642338; Tokyo, Japan) & 90 diopter lens (volk 90D) non-contact lens was used with stereoscopic slit lamp bio microscopy to evaluate the posterior segment of each subject. Both pupils of each subject were fully dilated. Posterior segment was evaluated to detect presence or absence of any abnormalities. The macular area was meticulously examined.

All patients in the study underwent OCT investigation: The OCT scanner is a fully computerized instrument that acquire and analyze cross-sectional tomograms of ocular tissue. These high depth resolution cross-sectional images of retina are obtained through noninvasive, non contact low coherence interferometry and may be useful for identifying, monitoring and quantitatively assessing macular and retinal disease.

Statistical analysis:

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 23. The quantitative data with parametric distribution were presented as mean, standard deviations and ranges. Also qualitative variables were presented as number and percentages. The p-value was considered significant as the following: p-value >0.05: Non significant (NS), p-value <0.05: Significant (S), p-value <0.01: Highly significant (HS).

The Following 3 cases are examples of subjects from our 3 study groups:

- Case 1 is a subject from the control group (emmetropic subjects).
- Case 2 is a subject from the myopic group.
- Case 3 is a subject from the hypermetropic group.

An OCT of 33 years old female.

Table (1): RNFL thickness in emmetropic subject.

Age	Autorefraction				RNFL thickness				
	SPH.	CYL	AXIS	S.E	WHOLE	INF.	SUP.	NASAL	TEMP.
33	0.00	–0.50	79	–0.25	116	140	170	73	80

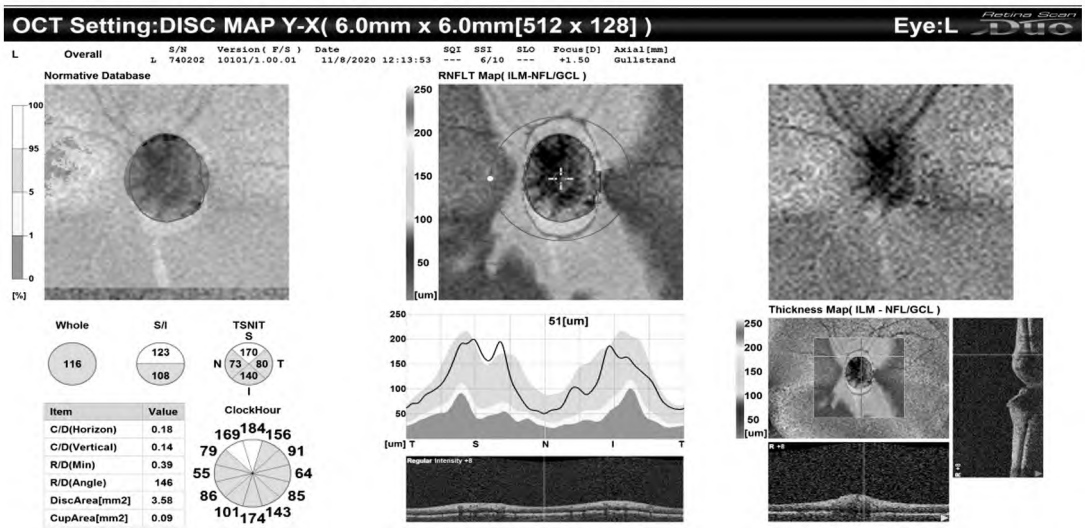

Fig. (1): OCT of RNFL thickness in emmetropic subject.

An OCT of 18 years old female.

Table (2): RNFL thickness in myopic patient.

Age	Autorefraction				RNFL thickness				
	SPH.	CYL	AXIS	S.E	WHOLE	INF.	SUP.	NASAL	TEMP.
18	–4.50	–1.25	122	–5.25	86	98	103	59	85

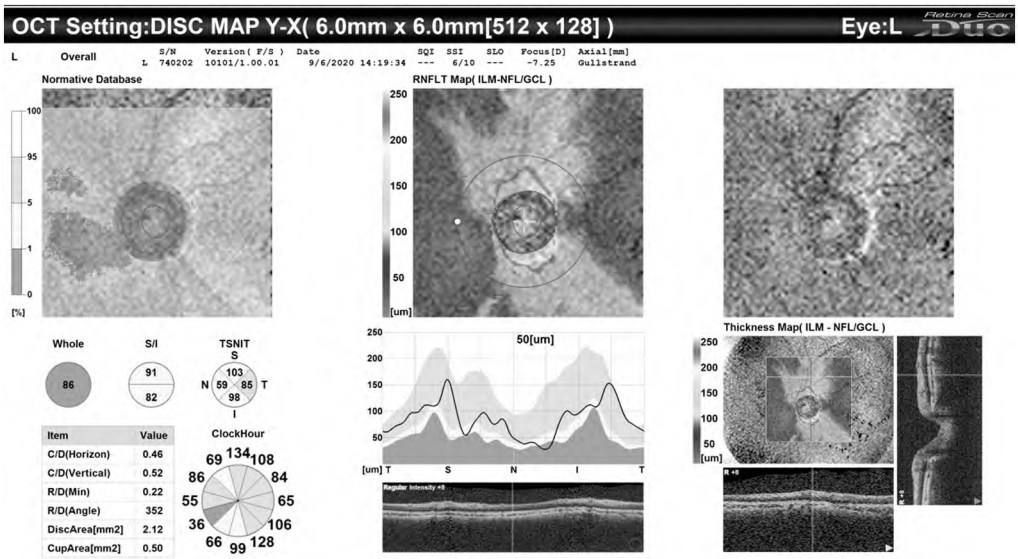

Fig. (2): OCT of RNFL thickness in myopic patient.

An OCT of 57 years old male.

Table (3): RNFL thickness in hypermetropic patients.

Age	Autorefraction				RNFL thickness				
	SPH.	CYL	AXIS	S.E	WHOLE	INF.	SUP.	NASAL	TEMP.
57	+4.25	–1.00	71	+3.5	93	114	127	64	68

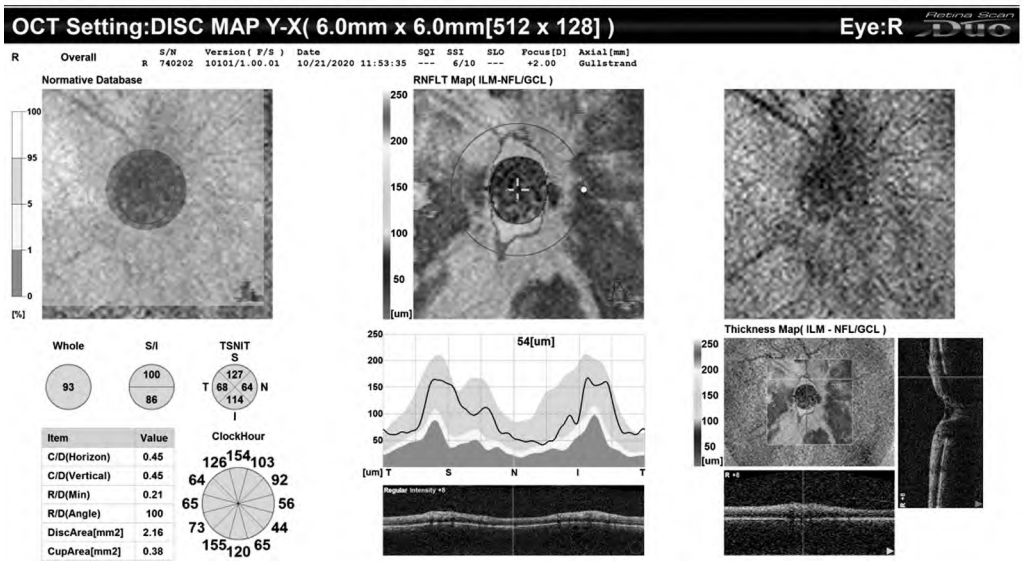

Fig. (3): OCT of RNFL thickness in hypermetropic patients.

Results

Our study included a total of 23 eyes of control group with a mean age of 52.30 years ± 14.77 and 45 eyes of patients group with a mean age of 53.62 years ± 17.71.

The mean age of emmetropic subjects was 52.304± 14.766, mean age of myopic patients was 51.520 ±18.782 and mean age of hypermetropic patients was 56.250± 16.348. This is shown in Table (3) and Figs. (1-3). There was no statistically significant difference between emmetropic, myopic and hypermetropic patients regarding age and sex.

Regarding RNFL thickness findings in errors of refraction, there was statistically significant increase in whole, INF, SUP in hypermetrope than in emmetrope and myope with p-value = 0.004, 0.002 and 0.007 respectively while no statistically significant difference found between them regarding nasal and temporal.

We found that there is increase in RNFL thickness in hypermetropic eyes in all quadrants except temporal quadrant with mean whole thickness range 111.20±55.17, mean inferior quadrant thickness range 141.85 ±69.52, mean superior quadrant thickness range 138.80 ±78.01, mean nasal quadrant thickness range 83.10 ±56.70 and mean temporal quadrant thickness range 79.05 ±28.27. In myopic eyes there was decrease in RNFL thickness in all quadrants except that of temporal quadrant with mean whole thickness range 86.80 ±30.47, mean inferior quadrant thickness range 101.16 ±39.50, mean superior quadrant thickness range 98.04 ± 39.51, mean nasal quadrant thickness range (62.60 ± 25.44) and mean temporal quadrant thickness range 79.05±28.27.

The relation of pRNFL thickness and spherical equivalent for phakic eyes are presented in Table (6) with increasing myopic refractive error the pRNFL thickness decreases, so, we found that there is statically significant association between error of refraction and RNFL thickness.

Table (4): Demographic, characteristics and RNFL thickness parameters of all the studied subjects.

	No. = 68
Sex:	
Female	29 (42.6%)
Male	39 (57.4%)
Age:	
Mean ± SD	53.18± 16.67
Range	18-80
Age 18-30	7 (10.3%)
Age 30-40	5 (7.4%)
Age above 40	56 (82.4%)
SPH:	
Mean ± SD	–0.18±4.39
Range	–12-6.75
CYL:	
Mean ± SD	–1.44± 1.36
Range	–6-0.75
AXIS:	
Mean ± SD	88.46±3 8.69
Range	0-179
S.E:	
Mean ± SD	–1.16±4.47
Range	–13.75-5.75
Emmetrope	23 (33.8%)
Myope	25 (36.8%)
Hypermetrope	20 (29.4%)
WHOLE:	
Mean ± SD	96.71±37.55
Range	38-332
INF:	
Mean ± SD	119.97±49.81
Range	16-410
SUP:	
Mean ± SD	114.47±53.01
Range	12-456
NASAL:	
Mean ± SD	72.37±37.84
Range	11-300
TEMP:	
Mean ± SD	76.50±35.70
Range	26-299
IOP:	
Mean ± SD	13.66±2.30
Range	10-21

Table (5): Comparison between control group and patients group regarding age and sex of the studied patients.

	Control group No. = 23	Patients group No. = 45	Test value	p-value	Sig.
Age:					
Mean ± SD	52.30± 14.77	53.62± 17.71	–0.306•	0.760	NS
Range	28-80	18-80			
Age 18-29	1 (4.3%)	6 (13.3%)	2.368*	0.306	NS
Age 30-40	5 (21.7%)	5 (11.1%)			
Age above 40	17 (73.9%)	34 (75.6%)			
Sex:					
Female	8 (34.8%)	21 (46.7%)	0.879*	0.349	NS
Male	15 (65.2%)	24 (53.3%)			

p-value >0.05: Non significant (NS). p-value <0.05: Significant (S). p-value <0.01: Highly significant (HS).
*:Chi-square test. •: Independent t-test.

The previous table shows that there was no statistically significant difference found between control group and patients group regarding age and sex.

Table (6): Comparison between emmetrope, myope and hypermetrope groups regarding age and sex of the studied patients.

	Emmetrope No. = 23	Myope No. = 25	Hypermetrope No. = 20	Test value	*p*-value	Sig.
Age:						
Mean ± SD	52.304± 14.766	51.520± 18.782	56.250± 16.348	0.487•	0.616	NS
Range	28-80	18-72	18-80			
Age 18-30	1 (4.3%)	4 (16.0%)	2 (10.0%)	4.099*	0.393	NS
Age 30-40	5 (21.7%)	4 (16.0%)	1 (5.0%)			
Age above 40	17 (73.9%)	17 (68.0%)	17 (85.0%)			
Sex:						
Female	8 (34.8%)	11 (44.0%)	10 (50.0%)	1.042*	0.594	NS
Male	15 (65.2%)	14 (56.0%)	10 (50.0%)			

p-value >0.05: Non significant (NS). *p*-value <0.05: Significant (S). *p*-value <0.01: Highly significant (HS).
*:Chi-square test. •: One way ANOVA test.

The previous table shows that there was no statistically significant difference found between emmetropic subjects, myopic patients and hypermetropic patients regarding age and sex.

Table (7): Relation between age of the studied patients and RNFL thickness in the whole and 4 quadrants.

	Age 18-29 No. = 6	Age 30-40 No. = 5	Age above 40 No. = 34	Test value	*p*-value	Sig.
Whole:						
Mean ± SD	98.17± 16.07	77.00± 10.51	100.59±50.02	5.230‡	0.073	NS
Range	78-123	61-87	38-332			
Inferior:						
Mean ± SD	126.00± 22.36	73.80±33.87	124.74±62.51	6.796‡	0.033	S
Range	98-163	16-100	54-410			
Superior:						
Mean ± SD	118.33± 26.14	82.20± 19.40	120.76±69.65	4.991‡	0.082	NS
Range	73-142	63-110	12-456			
Nasal:						
Mean ± SD	81.50± 29.36	54.40± 16.62	72.53± 47.28	2.519‡	0.284	NS
Range	52-121	32-74	11-300			
Temporal:						
Mean ± SD	67.17± 18.08	76.00±33.81	80.29± 46.39	0.109‡	0.947	NS
Range	36-85	43-133	26-299			

p-value >0.05: Non significant (NS). *p*-value <0.05: Significant (S). *p*-value <0.01: Highly significant (HS).
•:Independent *t*-test. ‡: Mann whitney test.

The previous table shows that there was no statistically significant difference found between the three age groups regarding RNFL thickness except INF quardant as there was statistically significant difference found.

The previous table shows that there was statistically significant increase in whole, INF, SUP in hypermetrope and in emmetrope than myope with *p*-value = 0.004, 0.002 and 0.007 respectively while no statistically significant difference found between them regarding nasal and temporal.

The previous table shows that there was statistically significant positive correlation found between S.E and whole, INF, SUP and nasal while no statistically significant correlation found between S.E and temporal and IOP.

Table (8): Comparison between emmetrope, myope and hypermetrope groups regarding RNFL thickness in the whole and 4 quadrants.

	Emmetrope No. = 23	Myope No. = 25	Hypermetrope No. = 20	Test value‡	*p*-value	Sig.
Whole:						
Mean ± SD	94.87±18.64	86.80±30.47	111.20±55.17	11.299	0.004	HS
Range	55-124	38-215	50-332			
Inferior:						
Mean ± SD	121.39±28.99	101.16±39.50	141.85±69.52	12.645	0.002	HS
Range	54-170	16-235	54-410			
Superior:						
Mean ± SD	111.17±27.25	98.04±39.51	138.80±78.01	10.004	0.007	HS
Range	61-170	12-222	66-456			
Nasal:						
Mean ± SD	73.65±25.73	62.60±25.44	83.10±56.70	5.059	0.080	NS
Range	46-161	19-153	11-300			
Temporal:						
Mean ± SD	73.43±17.77	77.28±51.20	79.05±28.27	1.612	0.447	NS
Range	44-123	26-299	36-162			

Post Hoc Analysis

Parameters	p_1	p_2	p_3
Whole	0.450	0.151	0.030
Inferior	0.147	0.165	0.006
Superior	0.377	0.081	0.010

p-value >0.05: Non significant (NS), *p*-value <0.05: Significant (S), *p*-value< 0.01: Highly significant (HS), ‡: Kruskal Wallis test.
*p*1: Emmetrope vs Myope. *p*2: Emmetrope vs Hypermetrope. *p*3: Myope vs Hypermetrope.

Table (9): Correlation between spherical equivalent (S.E) and RNFL thickness and IOP.

	S.E	
	r	*p*-value
Whole	0.320**	0.008
Inferior	0.427* *	0.000
Superior	0.380**	0.001
Nasal	0.292*	0.016
Temporal	0.039	0.749
IOP	0.064	0.605

Discussion

We found that in comparison with emmetropic eyes; the mean RNFL is thinner in myopes (superior, inferior and nasal quadrants) with no changes in temporal quadrant while in hyperopes there was an increase in the mean RNFL thickness in (inferior, superior and nasal quadrants) with no changes in temporal quadrant.

Our study showed positive correlation between spherical equivalent (s.e) mean range (–1.16±4.47) and peripapillary RNFL thickness, i.e. as the s.e decreases, there was thinning of RNFL in most cases.

Spoorthy et al. [8] in 2020 who conducted the study on 90 cases, 36 (40%) myopes, 24 (26.66%) hyperopes and 30 (33.33%) emmetropes, with mean RNFL thickness in myopes (90.86±10.50 mm), in hyperopes (116±3.6mm) and emmetropes (120±4.3mm). Mean RNFL is thinner in myopes than in emmetropes with superior and inferior quadrants thinning but in contrast to our study there was no mean RNFL thickness changes in hyperopes when compared to emmetropes.

Lee et al. [9] in 2015 who conducted the study on 201 subjects eligible for the study. There were 98 female and 103 male subjects; all were of Chinese ethnicity. There were 67 (33.1 %) myopic eyes, 61 (30.1%) emmetropic eyes, and 73 (36.3%) hyperopic eyes.

The association between myopia and a thinner RNFL has been well documented in adults although there are others who have reported differently.

We found that the mean global RNFL in the myopic group was still significantly thinner than the other 2 groups (both *p* 0.0001), but there was no significant difference in RNFL thickness between the emmetropic and hyperopic groups (*p*>0.05). This suggested that the thinner RNFL in

the myopic group was attributed to both an older age as well as refraction related factors. On the contrary, hyperopia did not confer a thicker RNFL as compared with those with emmetropia.

Öner et al. **[10]** in 2013 found that Mean peripapillary RNFL was thinner in the myopic group than in the control group (96.9 ± 11.9). The RNFLs were thinner in the superior (118.1 ±20.4), inferior (122.6± 16.5) and temporal (62.8 ± 18.7) quadrants; whereas in contrast to our study it was thicker in the nasal quadrant (82.2 ±22.2). Although the RNFL was thicker in the nasal quadrant (82.2 ± 19.0) in the hyperopic group; and in contrast to our study they have found no difference between the hyperopic and control groups regarding the mean peripapillary RNFL thickness (98.4 ± 10.2).

Rauscher et al. **[11]** found a significant strong association between axial length and the mean peripapillary RNFL thickness in superior and inferior quadrants but less strong relationship was found between SE and RNFL thickness of the both quadrants in myopic patients. That study included 27 patients and we believe that the sample size was too small to give a reliable result. In another study including 115 eyes showed that there were significant correlations between RNFL thicknesses (inferior, superior and nasal quadrant) and SE.

Kim et al. **[12]** demonstrated that the eyes with high myopia had significantly thinner RNFLs in the non-temporal sectors compared with the eyes with low myopia, and they showed a significantly thicker RNFL in the temporal quadrant.

References

1- OWNSEND K.A., WOLLSTEIN G. and SCHUMAN J.S.: Imaging of the retinal nerve fiber layer for glaucoma. Br. J. Ophthalmol., 93: 139-43, 2009.

2- SOWMYA V., VENKATARAMANAN V.R. and VISHNU K.P.: Analysis of retinal nerve fiber layer thickness using optical coherence tomography in normal South Indian population. Muller J. Med. Sci. Res., 5: 5-10, 2014.

3- NAGAI-KUSUHARA A., NAKAMURA M., FUJIOKA M., TATSUMI Y. and NEGI A.: Association of retinal nerve fibre layer thickness measured by confocal scanning laser ophthalmoscopy and optical coherence tomography with disc size and axial length. Br. J. Ophthalmol., 92: 186-90, 2008.

4- SOWMYA V., VENKATARAMANAN V.R. and PRASAD V.: Effect of Refractive Status and Axial Length on Peripapillary Retinal Nerve Fibre Layer Thickness: An Analysis Using 3D OCT. J. Clin. Diagn. Res., 9: NC01-4, 2015.

5- World Health Organization: What is a refractive error? 2013. http:// www.who.int/features/qa/ 45/en/. accessed May 3, 2014.

6- ALASIL T., WANG K., KEANE P.A., et al.: Analysis of normal retinal nerve fiber layer thickness by age, sex, and race using spectral domain optical coherence tomography. J. Glaucoma., 22: 532-541, 2013.

7- CARPINETO P., CIANCAGLINI M., ZUPPARDI E., FALCONIO G., DORONZO E. and MASTROPASQUA L.: Reliability of nerve fiber layer thickness measurements using optical coherence tomography in normal and glaucomatous eyes. Ophthalmology, 110: 190-95, 2003.

8- SPOORTHY S. and SHRUTHI K.P.: Peripapillary retinal nerve fibre layer thickness variation in refractive errors among adults. Indian J. Clin. Exp. Ophthalmol., 6 (3): 410-412, 2020.

9- LEE J.W., WOO T.T., YAU G.S., et al.: Cross-sectional study of the retinal nerve fiber layer thickness at 7 years after an acute episode of unilateral primary acute angle closure. Medicine (Baltimore), 94: e391, 2015.

10- ÖNER V., AYKUT V., TAŞ M., ALAKUŞ M.F. and IŞCAN Y.: Effect of refractive status on peripapillary retinal nerve fibre layer thickness: A study by RTVue spectral domain optical coherence tomography. British Journal of Ophthalmology, 97 (1): 75-9, 2013.

11- RAUSCHER F.M., SEKHON N., FEUER W.J. and BUDENZ D.L.: Myopia affects retinal nerve fiber layer measurements as determined by optical coherence tomography. Journal of Glaucoma., 18 (7): 501, 2009.

12- KIM M.J., LEE E.J. and KIM T.W.: Peripapillary retinal nerve fibre layer thickness profile in subjects with myopia measured using the Stratus optical coherence tomography. Br. J. Ophthalmol., 94: 115-20, 2010.

تقييم العلاقة بين سماكة طبقة ألياف الشبكية العصبية في قصر النظر مقارنة بطول النظر بواسطة التصوير المقطعى للشبكية

المقدمة: لقد تطور التصوير المقطعى للشبكية على مدار العقد الماضى كواحد من أهم الاختبارات المساعدة فى ممارسة طب العيون. يتيح التصوير المقطعى للشبكية الحصول على تصوير مقطعى غير موسع وسريع وموضوعى وعالى الدقة لشبكية العين و (طبقة الالياف العصبية بالشبكية) والعصب البصرى ويسمح أيضاً بالتصوير المباشر لأمراض العين التى لم يكن من الممكن فى السابق تصويرها باستخدام الطرق التقليدية.

الهدف من البحث: الغرض من هذه الدراسة هو تقييم العلاقة بين سمك طبقة ألياف الشبكية العصبية فى قصر النظر مقارنة بطول النظر بواسطة التصوير المقطعى للشبكية.

المرضى وطرق البحث: تضمنت دراسة مقارنة ما مجموعة ٦٨ عيناً مقسمة: ٤٥ عيناً تعانى من أخطاء فى الانكسار و ٢٣ عيناً سليمة فى الفترة من مارس ٢٠٢٠ إلى سبتمبر ٢٠٢٠ مقسمة إلى مجموعات: قصر النظر (فوق –٤ د) ، طول نظر (فوق +٤ د)، وعيون سليمة.

النتائج: أظهرت النتائج التى تم العثور عليها فى دراستنا أن هناك فروق ذات دلالة إحصائية فى سمك طبقة الألياف العصبية بالشبكية بين العيون ذات قصر النظر والعيون ذات طول النظر مقارنة بالعيون السليمة.

استنتاج: يتناقص سمك طبقة الألياف العصبية بالشبكية فى العيون ذات قصر النظر فى جميع أجزاء الشبكية بأستثناء الربع الخارجى، بينما يزيد سمك طبقة الألياف العصبية بالشبكية فى العيون ذات طول النظر فى جميع الأجزاء بأستثناء الربع الخارجى.