Original Article

Macular thickness correlation with gender and age in a sample of healthy eyes of Iraqi population utilizing optical coherence tomography

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Objective: To examine the impact of age and gender on macular thickness measures in healthy Iraqi eyes by utilizing optical coherence tomography (OCT).

Methodology: Macular scanning was performed on 200 healthy adult volunteers (age 20 and over) utilizing Zeiss Cirrus-high-definition HD-OCT. Each subject's macular thickness was measured in all nine locations of Early-Treatment-Diabetic-Retinopathy Study (EDTRS) map.

Results: Average age of volunteers was 37 ± 10.4 years (range 21 – 67). The central fovea had a thickness of 254.6 ± 17.3 μm. The average macular thickness was 279.0 ± 10.7 μm, and macular volume was 10.0 ± 0.4 mm^3. In all nine ETDRS locations apart of outer inferior quadrant, females had a considerably narrower macula (p = 0.001) than males. The correlation between thickness of central fovea and age was found to be very poor and not statistically significant. The mean macular thickness and volume in all other macular areas other than central foveal thickness exhibited statistically significant nonlinear decline with age (p < 0.001).

Conclusion: Using Zeiss Cirrus HD-OCT, mean data for central foveal thickness in healthy Iraqi eyes ranges from 237.7 μm to 272.0 μm. This is vital as a baseline to diagnose and treat macular diseases in Iraqi eyes.

Keywords: Maculopathy, macular thickness, optical coherence tomography.

INTRODUCTION

Given its powerful resolution and cross-sectional data, optical-coherence-tomography (OCT) has emerged as a crucial imaging technique. As a result, OCT may be used to diagnose and treat a variety of macular disorders.[1] There is a lot of variance in macular thickness (MT) across people of different ages, gender and races.[2] There are macular senile changes in structure, functions and blood flow. Multifactorial interaction comprising hereditary and/or environmental factors would accelerate aging process via triggering a progressive central vision deterioration, as seen in senile macular degeneration. Sex hormones are capable of modifying some factors.[3]

Moreover, it was found that females have thinner macula than males. [4] The MT map technique by OCT was implemented to measure the MT. It consists of a series of 6 – 24 evenly spaced line-scans made up of 512*128 (vertical/horizontal) axial scans examining a macular region of 6*6 mm. As established by the ETDRS, it creates a false-color topographic image showing numeric averages for thickness measurements for each of the nine map areas within a 6*6 mm area centered on fovea. [5] In this study, we examine the impact of age and gender on MT measures in healthy Iraqi eyes by utilizing OCT.

METHODOLOGY

This study was carried out from April 2017 to February 2018 and 400 eyes of 200 healthy Iraqi volunteers were subjected to MT measurements by OCT at Ibn Al-Haitham Teaching Eye Hospital. The study was authorized by Al-Kindy College of Medicine's Ethics council in Baghdad, Iraq and all participants provided their informed written consent.

Inclusion criteria were age range 20 to70 years with best-corrected visual acuity (BCVA) (≥ 6/6) using Snellen's chart. Emmetropic subjects or those with spherical equivalent of refractive error ranged (from -1.0 to + 1.0) diopter. Exclusion criteria were an intraocular pressure (> 21 mmHg) or any other signs of glaucoma, eyes having acquired or hereditary macular disease like hypertensive retinopathy, diabetic retinopathy, senile macular degeneration or hereditary macular dystrophy. Patients who have had previous ocular procedures, such as cataract, photorefractive, glaucoma, or vitreoretinal operations, as well as any retinal laser or cryotherapy were excluded.

A complete medical, ophthalmic history, and ocular examination was performed on each participant, which included (testing of best-corrected visual acuity with Snellen's-chart, intraocular-pressure measurement by Goldman applanation tonometer, slit-lamp examination of anterior segment, fundus examination using non-

contact + 90 D slit-lamp indirect lens), and patient was then referred for OCT.

Optical Coherence Tomography Scanning: All persons were scanned by same OCT device (Cirrus HD OCT Carl Zeiss Meditec, Dublin, CA, model 5000. software version 7.0). Pupillary dilatation was done by using topical tropicamide 1% eye drops, imaging was done 3 times on same day for each subject, by same well- trained technician. The image quality factor for All scans was 6/10 or more and was taken as near to fovea as much as possible in order to evade errors in measurements of thickness due to minor changes in location. The images were considered satisfactory only where extent and depth of retina were clearly evaluated; in addition, no blinking artifacts or ocular movements were accepted.

MT Measurements: The average of three scans acquired from each individual were used for analysis. MT measurements produced by OCT system in all nine regions of ETDRS map were analyzed utilizing three scans received from each participant. The fovea's thickness was measured as thickness of macula's innermost 1 mm ring. The average MT implementing all nine locations of ETDRS map was used to calculate mean thickness of macula.

Statistical Analysis: SPSS version 24 was used for the statistical analyses. ANOVA test (analysis of variance) was employed to compare means across age groups. $p < 0.05$ was considered significant.

RESULTS

We enrolled 200 participants with a mean age of 37.9 ± 10.4 years (range 21 – 67). Males represented 64% of the studied group. A total of 400 eyes were examined. The mean retinal thickness ranges from thicker value of (325 μm) at inner nasal to the thinner value of (254.6 μm) at the central foveal (Table 1).

The comparison of retinal thickness in both genders revealed significant differences in all measurements that males are likely to have thicker macular measurements than females ($p < 0.001$) in all parameters (mean MT, central foveal thickness (CFT), and macular volume). Also, males had thicker measurements in other eight quadrants than females ($p < 0.001$) except outer inferior quadrant at which males had relatively higher thickness but difference is not significant) ($p > 0.05$), (Table 2).

A significant correlation was found between retinal thickness and age. In all quadrants, retina was thicker in younger age groupsof 40 years and less and it becomes thinner with advancing age is above 40 years of life ($p < 0.001$) in all comparisons across age groups and 8 quadrants**.** CFT was not significant with age ($p > 0.05$). MT and volume cubewere higher in younger age also (Table 3 and Fig. 1).

Using average of pericentral 4 quadrants (inner ring), an average of peripheral 4 quadrants (outer ring) and central foveal ring; fractional polynomial multiple linear regression analysis was conducted according to age of patients and revealed a significant non-linear correlation between pericentral and peripheral thickness with age ($p < 0.05$), while correlation between thickness at central foveal area and age were insignificant ($p > 0.05$).

Table 1: Distribution of MT of total eyes according in different quadrants from thicker quadrant toward thinner one (N = 400).

Parameter	Mean μm	SD	Minimum μm	Maximum μm
Inner nasal	325.0	15.2	241	367
Inner superior	323.9	15.1	290	378
Inner inferior	321.2	14.9	289	382
Inner temporal	310.5	14.5	278	367
Outer nasal	295.7	15.3	236	346
Outer superior	277.6	14.8	171	330
Outer inferior	269.1	14.2	206	374
Outer temporal	261.7	13.4	206	309
Central foveal	254.6	17.3	218	295
Mean MT	279.0	10.7	257	316
Volume cube (mm3)	10.0	0.4	9.3	11.4

Table 2: Comparison of mean MT in different quadrants between both genders (N = 200).

Parameter	Male		Female		Mean Difference	Statistic	
	Mean µm	SD	Mean µm	SD		t test	p value
Central foveal	262.1	18.4	241.4	9.2	20.7	9.29	< 0.001
Inner nasal	328.5	15.6	318.8	12.4	9.7	6.40	< 0.001
Inner inferior	324.2	14.8	315.9	13.6	8.3	5.57	< 0.001
Inner temporal	314.2	14.8	303.9	11.3	10.3	7.24	< 0.001
Inner superior	327.6	16.0	317.3	10.5	10.3	6.96	< 0.001
Outer nasal	298.5	15.5	290.6	13.6	8.0	5.14	< 0.001
Outer inferior	269.9	15.2	267.6	12.1	2.3	1.54	0.125
Outer temporal	264.4	14.0	257.0	10.8	7.5	5.55	< 0.001
Outer superior	279.3	16.2	274.5	11.5	4.7	3.09	< 0.001
Mean MT	281.5	11.2	274.5	8.1	6.7	6.5	< 0.001
Volume cube (mm3)	10.1	0.4	9.9	0.3	0.22	5.9	< 0.001

Table 3: Comparison of mean MT in different quadrants by age (N = 200).

	Age (year)								ANOVA statistics	
	21 – 30		31 – 40		41 – 50		> 50			
	Mean µm	SD	Mean µm	SD	Mean µm	SD	Mean µm	SD	F	p value
Central foveal	250.2	26.8	258.1	33.4	247.6	30.6	254.6	22.7	3.38	0.11
Inner nasal	327.8	13.1	328.5	17.2	318.7	13.2	318.6	9.8	13.0	< 0.001
Inner inferior	322.6	13.2	324.1	16.3	315.6	13.4	318.0	12.8	7.1	< 0.001
Inner temporal	311.2	13.1	313.5	16.7	305.3	12.9	307.1	8.9	7.0	< 0.001
Inner superior	324.3	12.8	328.7	16.8	317.2	13.2	317.9	9.8	15.3	< 0.001
Outer nasal	298.6	15.7	296.5	17.2	294.8	11.0	289.8	11.9	4.5	0.004
Outer inferior	270.1	15.0	270.0	13.2	269.9	17.3	264.1	9.9	3.0	0.029
Outer temporal	259.8	11.5	264.3	15.3	261.5	11.8	258.1	11.3	4.4	0.005
Outer superior	276.9	12.4	281.2	15.3	276.8	13.3	269.6	15.9	10.1	< 0.001
Mean MT	279.5	10.5	281.7	11.4	276.4	9.8	273.9	7.3	10.4	< 0.001
Volume cube (mm3)	10.0	0.4	10.1	0.4	9.9	0.4	9.8	0.3	9.0	< 0.001

DISCUSSION

The nasal quadrant was thickest in inner region of macula, then superior, inferior and temporal quadrants, also in outer region, nasal quadrant also was thickest, then superior, inferior and temporal quadrants. These patterns were present in both genders and among all age groups because nasal macula has thickest nerve fiber layer as a result of presence of papillo-macular bundle then superior and inferior arcuate bundling of nerve fibers and finally temporal macula. Our findings are comparable with other studies.[6,7] Our study showed that CFT doesn't correlate significantly with age, as seen in Table 3.

Mean MT and macular volume measurements were

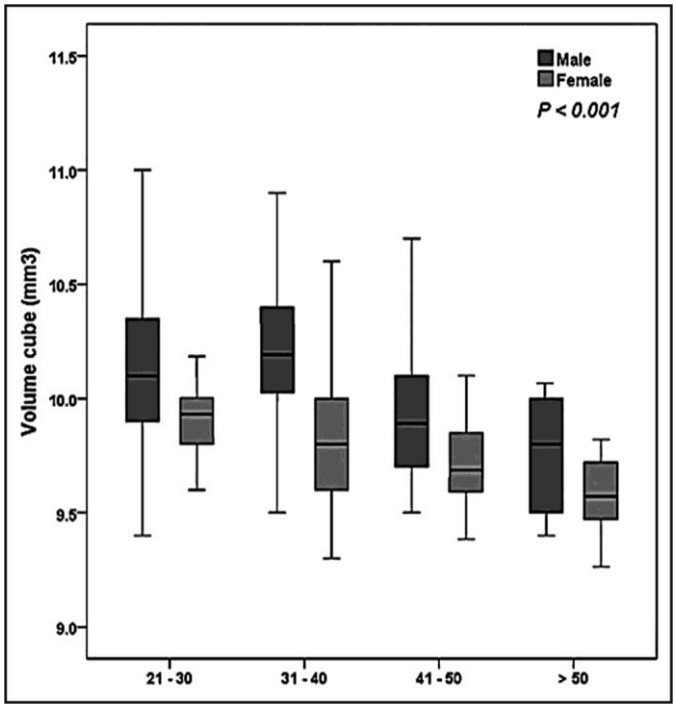

Fig. 1: Comparison of mean volume cube at different age group in both genders.

significantly thicker in age groups 40 years and less and became thinner in age groups more than 40 years ($p < 0.001$) (Table 3). These findings indicate that young adults have deeper foveal depression and, to a lesser extent, thicker macular regions than older people. The decreased thickness variation outside central macula may be due to aging-related ganglion cell loss and thinning of retinal nerve fiber layer, which cannot be seen in central fovea because there is no retinal nerve fiber layer. [8] A histological loss in photoreceptors, ganglion cells, and retinal pigment epithelial cells with age supports age-related drop in retinal thickness. [9] These findings coincide with that of Appukuttan et al, Subhi et al, and Hanno et al where significant correlation was found in all ETDRS subfields except central subfield. [6,10,11]

In comparison to women, men had larger CFT, mean MT, and macular volume ($p < 0.001$). In all 9 ETDRS locations, females had a substantially thinner maculae ($p < 0.05$) than males, with exception of outer inferior quadrant, which was not statistically significant ($p = 0.125$).

CFT was found to be 262.1 ± 18.4 μm, 241.4 ± 20.7 μm for males versus females. The average MT was 281.5 ± 11.2 μm, 274.5 ± 8.1 μm for males versus females. Grover et al[12] and Tewari et al[13] reported no significant difference was seen in foveal thickness, mean MT and macular volume in males and females which may be due to differences in ethnicity of study subjects or differences in study design. However, other similar studies found males to had significantly higher mean MT, foveal thickness, and macular volume as compared to females which were in partial agreement with our study as outer inferior quadrant was not statistically significant. Thus, high incidence of macular holes in females could be explained by thinner fovea.[6,11,14,16]

Asians and blacks have been shown to have much smaller central inner MT and volume than whites, not only in adults but also in youngsters.[16-18] To compare our results with different racial groups, we should have same OCT device (Cirrus-HD OCT) in comparable studies because measurements with different OCT devices may give different measurements.[1 9] CFT in our study was 254.6 ± 17.3 μm, which is close to CFT in Iranian subjects 255.4 μm² [0] but thicker than Indian subjects 240.4 ± 18.26 μm.[7]

The number of participants above age of 60 was modest. The results of the study cannot be compared with results of other ethnic groups like Africans and American Africans because of lack of data of these ethnic groups by using same OCT device.

CONCLUSION

Using Zeiss Cirrus HD-OCT, mean data for central foveal thickness in healthy Iraqi eyes ranges from 237.7 μm to 272.0 μm. This is vital as a baseline to diagnose and treat macular diseases in Iraqi eyes.

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