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Variation in macular thickness in healthy eyes with or without myopia using optical coherent tomography

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Abstract

Background and objective: Difference in macular thickness is affected by age, gender and axial length in any ethnic group. The aim of this study is to report normal macular thickness measurement in healthy Iraqi eyes using Optical Coherence Tomography mapping software.

Methods: In this cross–sectional study, the macula of 150 eyes (75 healthy subjects) underwent a complete ophthalmic examination including Optical Coherence Tomography. Optical Coherence Tomography parameters of macular thickness were analyzed with baseline variables including age, gender and axial length.

Results: Mean central foveal thickness were 217µm and mean macular thickness in 6mm diameter were 245µm. Macular thickness measurement were thinnest at the center of the fovea, thickest within 3mm diameter of the center, and diminish toward the periphery of the macula. The temporal quadrant was thinner than the nasal quadrant. No correlation was found between macular thickness and age. The difference between male and female was significant ($P < 0.05$). The macula thickness was significantly less in eyes with axial length more than 24mm and more in eyes with axial length less or equal to 24mm ($P < 0.05$).

Conclusion: The macular thickness has a significant correlation with gender and axial length. This normal baseline data of macular thickness of the eyes of Iraqis living in Erbil may be a useful guideline for further research and management of glaucoma and macular diseases.

Keywords: Macula, OCT, Age, Gender, Axial length.

Introduction

Optical Coherence Tomography (OCT) is a new diagnostic technology for high-resolution, cross-sectional, quantitative imaging of the retina.[1,2] OCT uses light instead of sound wave and it is non-invasive non-contact technique which uses near infrared low coherent light passing through a Michelson interferometer. It measures the echo time delay and magnitude of reflected or backscatter to obtain two dimensional images of the retina and optic nerve head.[2] In clinical practice, the presence of macular edema does not necessarily preclude good vision.[3] Therefore, the degree of macular thickening rather than the presence of macular edema are significantly correlated with visual acuity.[4] In glaucoma, the essential ganglion pathologic process is the loss of retinal cells and their axon.[5] The introduction of OCT has enabled clinicians to reliably detect and measure small changes in macular thickness and to quantitatively evaluate the efficacy of different therapeutic modalities.[6] Retinal thickness is calculated as the distance between vitreoretinal interface and the anterior boundary of the red reflective layer corresponding to the retinal pigment epithelium (RPE). It is desirable that measurements derived from the normal population to be as close as possible to the population for which the instrument is to be used. The ethnics difference in the prevalence of age related macular degeneration affects macular thickness.[7-9] This may also explain some of the

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variation in macular thickness in different ethnic group. The aim of this study is to report normal macular thickness in healthy Iraqi subjects using the latest available OCT and to find out the relation of macular thickness with age, gender and axial length.

Methods

Subjects

This study included 150 eyes of 75 Iraqi subjects aged 18 to 46 years living in Erbil. It was conducted in the period from March to December 2011. Persons with history of glaucoma, trauma, laser therapy or intraocular surgery, posterior segment pathology including changes related to pathologic myopia, media opacity, family history of macular disease or glaucoma, unexplained visual loss and history of systemic disease like diabetes mellitus hypertension and rheumatic disease were excluded from the study.

Procedure

Informed oral consents were obtained from all subjects. A specially designed questionnaire was used to obtain demographic information, medical history and surgical history. The room was darkened to obtain dilatation and person sat on chair and put his chin on chin rest of the OCT and asked to gaze on internal fixation.

Statistical analysis

Data were analyzed using the statistical package for social sciences (SPSS, version 18). Student's t-test was used to compare between means. A "P" value of ≤ 0.05 was considered as statistically significant.

Results

The mean central foveal thickness was 217µm and ranged from 166-278 µm and standard deviation of 26, as expected macular thickness was thinnest at the center and thickest within 3mm diameter of the center inner ring and diminish toward the periphery.

Table 1: Mean STD deviation and range in nine sector of macula.

Region	Mean	Std. Deviation	range
Central foveal thickness (F1)	217	26	166-278
Inner superior ring (F3)	264	25	178-350
Inner nasal ring (F4)	264	27	204-349
Inner inferior ring (F5)	260	25	205-348
Inner temporal ring (F2)	246	28	170-330
Outer superior ring (F7)	235	21	172-289
Outer nasal ring (F8)	254	23	202-331
Outer inferior ring (F9)	239	26	174-343
Outer temporal ring (F6)	227	25	153-287

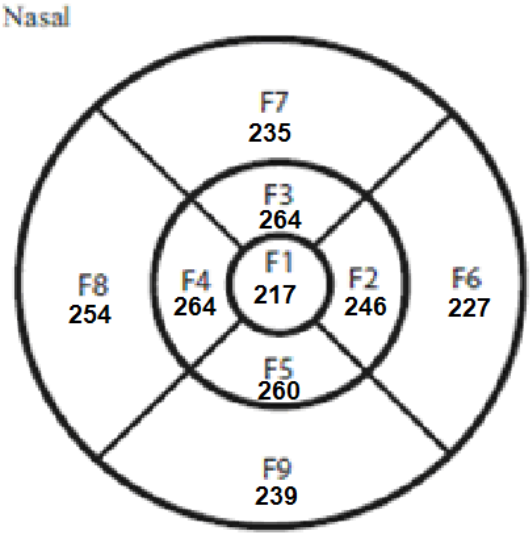

Diagram 1: Nine sector of macular thickness.

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Of nine parameters, more than halve in nine sector showed significant difference between male and female. Males had higher thickness than females. In comparison of the nine regions there was statically significant difference between the two groups and the thickness was higher in those with axial length less than 24mm.

Table 2: Difference in macula thickness between male and female.

	gender	N	Mean	SD	P value
Central foveal thickness (F1)	Male	70	223	21.00	.007
	Female	80	212	30.29	
Inner superior ring (F3)	Male	70	268	30.83	.031
	Female	80	260	18.16	
Inner nasal ring (F4)	Male	70	274	30.69	< .001
	Female	80	256	21.38	
Inner inferior ring (F5)	Male	70	266	30.78	.005
	Female	80	255	17.99	
Inner temporal ring (F2)	Male	70	255	31.77	< 0.001
	Female	80	238	22.61	
Outer superior ring (F7)	Male	70	238	23.51	.070
	Female	80	232	19.61	
Outer nasal ring (F8)	Male	70	258	24.17	.081
	Female	80	251	21.79	
Outer inferior ring (F9)	Male	70	242	34.02	.150
	Female	80	236	18.24	
Outer temporal ring (F2)	Male	70	231	27.59	.038
	Female	80	223	22.47	

Table 3: Macular thickness with different axial length.

	AL (mm)	N	Mean (µm)	Std. Deviation	P value
Central foveal thickness (F1)	≤24	107	229.57	28.54	< 0.001
	> 24	43	212.67	17.40	
Inner superior ring (F3)	≤24	107	269.68	22.44	< 0.001
	> 24	43	250.44	26.65	
Inner nasal ring (F4)	≤24	107	266.86	28.99	.144
	> 24	43	259.60	22.82	
Inner inferior ring (F5)	≤24	107	264.13	26.07	.007
	> 24	43	251.88	21.37	
Inner temporal ring (F2)	≤24	107	248.42	28.22	.123
	> 24	43	240.49	28.61	
Outer superior ring (F7)	≤24	107	240.23	20.05	< 0.001
	> 24	43	222.09	20.33	
Outer nasal ring (F8)	≤24	107	258.71	23.66	.001
	> 24	43	244.81	18.36	
Outer inferior ring (F9)	≤24	107	242.08	18.02	.029
	> 24	43	231.49	40.76	
Outer temporal ring (F6)	≤24	107	232.09	24.49	< 0.001
	> 24	43	214.56	22.97	

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Table 4: nomogram of MFT & MMT according to Sex and Axial length.

	Female	Male
MFT	212 µm	223 µm
MMT	240 µm	250 µm
	AL Less than or equal 24	AL more than 24
MFT	229 µm	212 µm
MMT	249 µm	235 µm

Discussion

The results showed a minimum central foveal thickness 166±26µm using the macula thickness scan protocol and retinal thickness. Many studies[10-13] have shown macular thickness at around 150µm, two studies[14,15] at approximately 175µm and one study at 210µm.[16] The mean (±SD) of central foveal thickness (average thickness in 1000 µm diameter area) was 217 (±26µm); this was thicker than previously reported value of 178. Clinicians should be aware of these discrepancies when interpreting OCT images from different OCT modality. These discrepancies may be a direct result of greater resolution achieved by more recent OCT system. Less movement by the patient because of faster scanning time and more refined algorithms have allowed better image quality and also may be related to ethnicity of the study group, the OCT model, the scan (e.g. radial vs. linear) and analysis protocol. This discrepancy highlights the importance of paying attention to the above variables before making comparisons. We showed that the inner nasal sector is the thickest and this is consistent with anatomical correlation of the converging of the nerve fibers to the optic disc and the temporal ring is thinnest all over and inner superior and inferior ring also thicker in comparison to outer ring. This is also consistent with anatomical relationship of the superior and inferior arcuate fiber that travel to the optic disc. Macula become thin to the periphery although this differs from previous study result on OCT1 that showed peripheral ring thicker. This is because OCT1 use scan diameter of 4.5mm and OCT3 use scan diameter 6mm and show more peripheral retina. Age had no significant correlation with central foveal thickness and mean macula thickness. Most studies on OCT,[16,17] with some exceptions,[18,19] have not reported an association between foveal thickness and age in mixed gender group, which is in agreement with our results for mean macular thickness (MMT). This study divided subjects into two groups according to axial length; less than and equal to 24mm and more than 24mm. There was significant difference between the two groups and this may explain anatomical lengthening of the eye and stretching of the retina. However, Wakitani *et al* found that retinal thickness in the three circular areas did not correlate with axial length of the eye.[20] This study also found a significant difference in macular thickness between males and females. This may be related to hormonal effect and this needs further investigation in female to see retinal thickness changes after menopause and in pregnancy. Indeed, estrogen receptors seem to protect the retina against age -inflicted injury[21] partly by inhibiting lipid peroxidation.[22] Estrogens have been associated with lower risk for Early Age Related Macular Degeneration (EAMD)[23,24] and exogenous estrogen seems to protect against late age –related degeneration.[25]

Conclusion

We have provided a normal baseline data for macular thickness in Iraqi Kurdish people by OCT. This could be useful in diagnosis, management and further research in macular disorder and glaucoma. Gender and axial length should be taken in consideration when measuring macular thickness. So we can make a nomogram of normal macular thickness according to sex and axial length. The following nomogram recommended although further studies are needed to increase our understanding of the possible association between increase

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in mean macula thicknesses and its relation with the gender, axial length, age and hormonal level.

Conflicts of interest

The authors report no conflicts of interest.

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