

## Normal Macular Thickness Measurements in Healthy Eye of Iraqi Volunteers by Using Optical Coherence Tomography

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### Abstract

**Aim:** To assess the normal macular thickness measurements in healthy eyes of Iraqi volunteers and its variation by gender and age using cirrus HD optical coherence tomography.

**Subjects and methods:** This is a cross sectional study in a sample of healthy eyes of Iraqi volunteers to examine the macular thickness by optical coherence tomography at Ibn Alhaithem Teaching Eye Hospital. The samples were matched for age and gender.

Optical coherence tomography analysis was undertaken with cubic macular thickness analysis in six radial scans centered at fovea dividing the macula into nine quadrants according to ETDRS (Early Treatment Diabetic Retinopathy Study) as well as the total macular volume and mean macular thickness that also be assessed.

**Results:** Two hundred normal eyes of one hundred healthy Iraqi volunteers were examined clinically and scanned by optical coherence tomography. The mean of central foveal thickness was  $245.65 \pm 20.159 \mu\text{m}$ , the mean macular thickness was  $277.64 \pm 12.356 \mu\text{m}$ , and the macular volume was  $9.995 \pm 0.44 \text{ mm}^3$ . Central foveal thickness was clinically significantly greater in male gender with  $p < 0.0001$  and mean macular thickness and volume were also clinically significantly thicker in male than female with  $p < 0.0001$ . Central foveal, mean macular thickness and volume changes were not clinically significant with age.

**Conclusion:** First normative macular thickness data in healthy Iraqi volunteers were obtained using cirrus HD OCT with a central foveal thickness measurements, mean macular thickness measurements were  $245.65 \pm 20.159 \mu\text{m}$ ,  $277.645 \pm 12.356 \mu\text{m}$  respectively and the macular volume were  $9.995 \pm 0.442 \text{ mm}^3$ . The male macula is thicker than female macula.

**Keywords:** Macular thickness; Optical coherence tomography; Healthy volunteers

central serous retinopathy, macular hole and age related macular degenerations [1,2].

### Introduction

Many systemic diseases and ocular disorders have effects on the macula and may cause an increase in retinal thickness of macula like diabetic maculopathy, retinal vein occlusion, uveitis, central serous chorioretinopathy, at the other side many diseases may cause macular atrophy like age related macular degeneration [1,2].

The introduction of optical coherence topography (OCT) has enabling the ophthalmologists to quantitatively and reliably evaluate the macular thickness, the total macular volume, measuring the small changes in macula and help in following up the effects of different therapeutic modalities [3,4].

Optical coherence tomography (oct) is a non-contact, non-invasive, high resolution tomographic and biomicroscopic device with three-dimensional imaging and axial cross sectional image that used in measuring both anterior and posterior ocular structures including cornea, retina, macula and optic nerve head [5,6]. The optical coherence tomography aid in diagnosis and management of many ocular diseases like cystoid macular edema, diabetic maculopathy,

### Aim of Study

To assess normal macular thickness measurements in healthy eyes of Iraqi volunteers and its variation by gender and age using cirrus optical coherence tomography

### Methods

This is a cross sectional study in a sample of a healthy eyes of Iraqi's volunteers to examine the macular thickness by OCT at Ibn Alhaithem Teaching Eye Hospital between December 2015 and July 2017 and the sample was matched for age and gender. Each volunteer underwent a complete medical and ophthalmic history and examination, including (best distal corrected visual acuity by Snellen chart, applanation tonometry by Goldman tonometer, slit lamp biomicroscopic examination, dilated fundus examination by non-contact 90 D slit lamp indirect lens) then referred to be examined by OCT.

A verbal informed consent was obtained from all volunteers before examination.

The following inclusion criteria for healthy eyes:

1. Age (20-65) years.
2. Best corrected visual acuity 6/6 using Snellen chart.
3. Refractive error between (-1 to +1).
4. Intra ocular pressure less than 21 mmHg.
5. Signal strength of OCT  $\geq 6$ .

And exclusion criteria that laid down:

1. Eyes with a media opacity that obscure oct view or signal of oct less than 6.
2. Intraocular pressure  $>21$  mmHg or any sign of glaucoma.
3. Eyes with retinopathy due to hypertension, diabetes, age related macular degeneration, macular dystrophies, macular holes, retinal vascular disease etc. or neuro-ophthalmological disease or previous intra ocular inflammatory diseases.
4. External eye disease that may interfere with tear film.
5. Patients had any ophthalmological surgical interventions, including cataract, refractive, glaucoma, posterior segment surgeries or any laser therapy or cryotherapy.

All the volunteers were examined by the same OCT device operator with pupillary dilatation by tropicamide 1% 3 times at 15 min interval to dilate the fundus with no use of artificial tear and ask the volunteer to blink as usual and scanned using optical coherence tomography (cirrus HD OCT model 5000 software version 7.0) and analysis was undertaken with cubic macular thickness analysis in six radial scan centered at fovea at equally spaced angular orientation dividing the macula into 3 area (central, inner and outer with a diameter of 1, 3 and 6 respectively) and nine regions as defined by ETDRS; one in the center, four in the inner area (inner superior, inner inferior, inner nasal, inner temporal) and four in the outer area (outer superior, outer inferior, outer nasal, outer temporal) as well as total macular volume and the mean macular thickness that assessed too.

Statistical analysis was performed by Microsoft Excel. Analysis of retinal thickness (mean and standard deviations), T Test, ANOVA test to assess the relationship of macular thickness with age and gender. The p-value less than 0.05 were considered to be statistically significant.

## Results

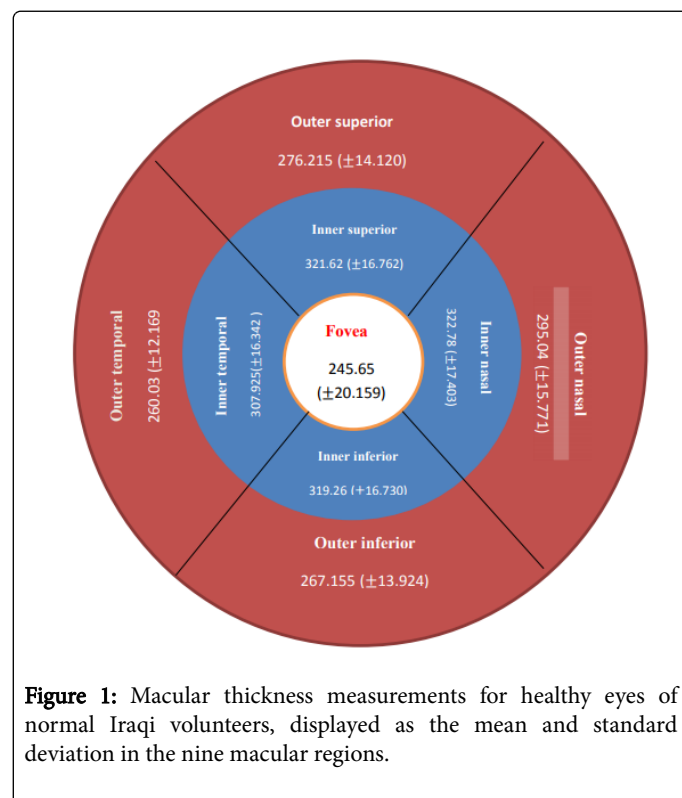
Two hundred normal eyes of one hundred healthy Iraqi's volunteers attending Ibn Alhathem Teaching Eye Hospital were examined clinically and scanned by OCT.

The volunteers were aged between 20 to 65 years (median, 37 years). The results obtained from 50 women (50%) and 50 men (50%). The mean and standard deviation of retinal thickness of each macular region, mean macular thickness and macular volume are shown in Table 1 and Figure 1 which show that macular thickness was thinnest at fovea (innermost 1 mm ring), thickest within (Inner 3 mm ring), and decreased at the periphery of macula (Outer 6 mm ring). The nasal macula was the thickest area followed by the superior and inferior areas while the temporal area was the thinnest.

Macular region	Macular thickness in 200 healthy eyes
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	(Mean $\pm$ SD)
Fovea (innermost 1 mm ring)	245.65 ( $\pm$ 20.159)
Inner 3 mm ring	
Superior	321.62 ( $\pm$ 16.762)
Inferior	319.26 ( $\pm$ 16.730)
Nasal	322.78 ( $\pm$ 17.403)
Temporal	307.925 ( $\pm$ 16.342)
Outer 6 mm ring	
Superior	276.215 ( $\pm$ 14.120)
Inferior	267.155 ( $\pm$ 13.924)
Nasal	295.04 ( $\pm$ 15.771)
Temporal	260.03 ( $\pm$ 12.169)
Mean macular thickness	277.645 ( $\pm$ 12.356)
Macular volume	9.995 ( $\pm$ 0.442)

**Table 1:** Macular thickness measurements in each region using Carl Zeiss cirrus HD OCT.



**Figure 1:** Macular thickness measurements for healthy eyes of normal Iraqi volunteers, displayed as the mean and standard deviation in the nine macular regions.

Gender factor show that males had more central foveal thickness, mean macular thickness and macular volume in comparison to female with ( $p < 0.05$ ) which was statically significant for all macular regions except the outer superior region ( $p = 0.060$ ) as shown in Table 2.

Macular region	Macular thickness in 200 healthy eyes (Mean $\pm$ SD)
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	Male eyes n=100 50%	Female eyes n=100 50%	P value for gender difference
Fovea (innermost 1 mm ring)	253.27 (± 20.337)	238.03 (± 16.910)	<0.001
Inner 3 mm ring			
Superior	327.04 (± 19.075)	316.2 (± 11.898)	<0.0001
Inferior	325.3 (± 18.431)	313.22 (± 12.217)	<0.0001
Nasal	329.58 (± 17.975)	315.98 (± 13.867)	<0.0001
Temporal	314.29 (± 17.481)	301.56 (± 12.222)	<0.0001
Outer 6 mm ring			
Superior	278.09 (± 15.177)	274.34 (± 12.780)	0.060
Inferior	269.9 (± 15.278)	264.41 (± 11.877)	0.005
Nasal	298.7 (± 17.187)	291.38 (± 13.323)	<0.0001
Temporal	262.33 (± 13.474)	257.73 (± 10.268)	0.007
Mean macular thickness	280.97 (± 13.503)	274.32 (± 10.109)	<0.0001
Macular volume	10.111 (± 0.488)	9.879 (± 0.359)	<0.0001

**Table 2:** Macular thickness measurement in each region by gender.

There was no clinically significant difference between the right and left eye in all macular areas as shown in Table 3.

Macular region	Macular thickness in 200 healthy eyes (Mean ± SD)		
	RIGHT EYE n=100 eyes 50%	Left eye n=100 eyes 50%	P value for laterality
Fovea (innermost 1 mm ring)	245.49 (± 21.31)	245.81 (± 19.04)	0.91
Inner 3 mm ring			
Superior	320.47 (± 16.67)	322.77 (± 16.86)	0.33
Inferior	318.93 (± 16.31)	319.59 (± 17.22)	0.78
Nasal	321.44 (± 16.72)	324.12 (± 18.04)	0.3
Temporal	307.62 (± 15.74)	308.23 (± 17)	0.89
Outer 6 mm ring			
Superior	274.95 (± 14.13)	277.48 (± 14.07)	0.21
Inferior	266.36 (± 13.93)	267.95 (± 13.94)	0.65
Nasal	294.98 (± 15.2)	295.1 (± 16.4)	0.96

Temporal	259.37 (± 12.19)	260.69 (± 12.17)	0.44
Mean macular thickness	277.75 (± 12.09)	277.54 (± 12.68)	0.9
Macular volume	9.997 (± 0.43)	9.993 (± 0.46)	0.95

**Table 3:** Macular thickness measurement comparison between right and left eyes.

According to the age factor, there was a decrease in the macular thickness measurements in all areas but clinically insignificant except the outer superior area which was slightly significant with p-value less than 0.05 as shown in Table 4.

Macular region	Macular thickness in 200 healthy eyes (Mean ± SD)		
	Age less than 40 years EYE n=118 eyes (59%)	Age more than 40 years n=82 eyes (41%)	P value for laterality
Fovea (innermost 1mm ring)	245.85 (± 18.01)	245.37 (± 23.01)	0.43
Inner 3 mm ring			
Superior	322.27 (± 16.74)	320.68 (± 16.86)	0.51
Inferior	320.27 (± 16.85)	317.8 (± 16.55)	0.31
Nasal	323.84 (± 17)	321.26 (± 17.96)	0.30
Temporal	308.79 (± 16.45)	306.68 (± 16.21)	0.37
Outer 6 mm ring			
Superior	278.1 (± 13.36)	273.5 (± 14.82)	0.02
Inferior	267.71 (± 14.1)	266.35 (± 13.71)	0.50
Nasal	296.52 (± 15.81)	292.9 (± 15.56)	0.11
Temporal	260.31 (± 12.93)	259.62 (± 11.05)	0.70
Mean macular thickness	278.85 (± 12.61)	275.91 (± 11.85)	0.10
Macular volume	10.04 (± 0.45)	9.93 (± 0.43)	0.10

**Table 4:** Macular thickness measurement in each region by age.

## Discussion

Macular area has a different thickness at a different areas and the thinnest area of the macular was at fovea (innermost 1 mm ring), then tend to be thicker within (Inner 3 mm ring), and decreased at the periphery of macula (Outer 6 mm ring). The thickest area is the nasal macula followed by the superior and inferior regions and lastly the temporal area and this is due to that the nasal macula has thickest nerve fiber layer due to the presence of the papillomacular bundle in it then the superior and inferior arcuate bundling of the nerve fibers and lastly the temporal macula, our results in agreement with Faghihi et al. [7] and other studies that show the superior and nasal regions were thickest overall [6]. We identified the nasal region as the thickest region within the central 3 mm diameter; this is in consistent with the anatomical thicker of the nerve fibre layer in the peripapillary area in agreement with, Hortensia Sánchez-Tocino and Manassakorn A and Annie Chan studies [8-10].

The male have significantly thicker central foveal thickness ( $p < 0.0001$ ), mean macular thickness ( $p < 0.0001$ ) and macular volume ( $p < 0.0001$ ) in comparing to the female which are in agreement with previous studies that have shown reduced retinal thickness in women compared with men [7,11-15] but few studies show no significant difference between males and females as Perez-Garcia [16] and Molnar A [17] studies but these study conducted in children and the differences may be due to growth and hormonal factors that may affect the results.

The macular thickness decrease with age but it was not clinically significant which agree with Faghihi et al. [7], Sanchez-Tocino [8] and Al-Zamil WM [18] which there results are not statistically significant with age while some study show a significant decrease with age as Liu T [19] study but this study enrolled subjects up to 90 years age while our study was up to 65 years age therefore we recommend a larger study with more range of age to be done.

Measurement with different oct devices may give a different measurement [20] and at the same time measurement with the same oct device may give a different measurement which may be due to a different ethnicity [21].

Ethnic differences in macular thickness and volume have been described. Central and inner macular thickness and volume were shown to be significantly thinner in blacks and Asians than in whites [22]. Wagner-Schuman [23] observed similar differences between the races in macular thicknesses, with the African/African American group having a significantly reduced central foveal thickness compared with the Caucasian group. In our study like Faghihi [7] central foveal thickness, mean macular thickness and macular volume were shown to be significantly thicker than blacks, Asians and whites but to compare between different ethics we need to compare by the same oct device because different oct device may give different measuring.

## Conclusion

First, normative macular thickness data in healthy Iraqi volunteers were obtained using cirrus HD OCT. Central foveal thickness measurements, mean macular thickness measurements were 245.65 ( $\pm 20.159$ ), 277.645 ( $\pm 12.356$ ) respectively thicker than data reported in other ethnicity (Black, Asian, Caucasian) and the male have thicker macula than female so age, sex and ethnicity are important factors which should be taken into account when interpreting macular thickness measurements with cirrus HD-OCT.

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