Macular Thickness Decreases with Age in Normal Eyes: A Study On Macular Thickness Map Protocol on the Oct

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ABSTRACT

Objective: To evaluate the normal macular thickness and how it varies with age in the eyes of healthy subjects using macular map protocol on Spectral-Domain Optical Coherence Tomography (SD-OCT).
Study Design: Cross-sectional study.
Place and Duration of Study: Armed Forces Institute of Ophthalmology, Rawalpindi Pakistan, from Jun 2020 to Sep 2021.
Methodology: Our study included one thousand seven hundred and four eyes (1704) of healthy subjects. They underwent imaging with macular thickness map protocol using Topcon Spectral-Domain Optical Coherence Tomography (SD-OCT). According to the macular thickness map, protocol macular area was subdivided into nine ETDRS fields. Measurement of macular thickness and its variations with age were determined. Pearson correlation was applied to identify the relationship between age and macular thickness of layers.
Results: Our study revealed a negative relationship which was statistically significant between macular thickness and age for all the ETDRS regions. Results showed a mean macular thickness of 274.90 ± 15.18. The female gender was found to have greater macular thickness than males (*p*-value 0.002).
Conclusion: This study concluded a significant decrease in macular thickness with age. This is the first normative study using Topcon SD-OCT and macular map protocol for macular thickness measurement done in the Pakistani population.

Keywords: ETDRS, Macular thickness, Optical coherence tomography.

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INTRODUCTION

As in many ophthalmic structures, for example, the corneal endothelium and trabecular meshwork, two age-related cell loss has been described in the superficial layer of the retina.[1,2] The ganglion cells of the optic nerve have been reported to reduce by 3000 to 5000 cells per year of age.[3,4]

Currently, Fundus fluorescein angiography (FFA) imaging is a widely used diagnostic system and vital for diagnosing many ocular diseases.[5] Fundus Fluorescein Angiography (FFA) images help detect a few diseases such as ARMD and DR. This test also got some side effects because it is an invasive procedure.[6]

The ophthalmic clinical practice has been revolutionized by introducing optical coherence tomography (OCT). OCT is an optical analogue of ultrasound imaging that provides cross-sectional retinal images with the help of low coherence interferometry. OCT scans through different layers of retinal tissue forming three-dimensional high axial resolution images (3-15 µm). For imaging disorders related to the retina, the technique of OCT is used most frequently.[7] When comparing SD-OCT with conventional time-domain OCT (TD-OCT) technique, SD-OCT imaging is superior to the latter due to its increased scanning speed of 25,000 to 100,000 scans/second. It scans 100 times faster than the TD imaging technique.[8]

Many studies have shown noteworthy differences in macular thickness among different demographic groups. These demographic variations are important parameters. Time now, SD-OCT is being used more in clinical practice. Comparing macular thickness in healthy eyes with different currently available OCT systems is essential. The main objective of our study is to make use of Topcon SD-OCT to evaluate how normal macular thickness varies with age and gender in healthy eyes.

METHODOLOGY

This cross-sectional study was carried out in accordance with the guidelines of the Declaration of Helsinki at AFIO from June 2020 to September 2021. The study was approved by the Institutional Ethical committee**.** With the help of the WHO sample size calculator, the sample size was calculated taking

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confidence level of 95%, which came out to be 1500 eyes.[9]

Inclusion Criteria: Patients of either gender who presented to the Armed Forces Institute of Ophthalmology, Rawalpindi, Pakistan, were enrolled in the study. Subjects with visual acuity of 20/20 with a refractive error of not more than five diopters were included in this study.

Exclusion Criteria: Subjects with any ocular or retinal pathology on ocular examination were excluded from this study.

Total 1704 eyes of healthy subjects with age ranging from 12 to 70 years (1221 males and 483 females), were recruited for this study. After informing subjects about the study, written and informed consent was taken from all subjects. Every subject had to undergo a detailed ocular examination, i.e., refraction, uncorrected and best OCT scanning was performed using Topcon OCT.

All the subjects were dilated using 0.5% Tropicamide and scans were performed after pharmacological dilation, and images were taken by a trained operator using the Topcon OCT system. Images with quality less than factor 60/100 or with motion artefacts were discarded.

For the measurement of thickness, a macular thickness map protocol was applied. It is a raster scan that contains axial scans of 256×256 consisting of 666 mm of the macular area. A raster scan is a high-resolution series of parallel line scans that can be aligned at any angle, constructing cross sectional tomographic images from repetitive axial A-scans. It forms a topographic image with thickness values for all nine regions within a 666mm area, with fovea being the centre, as described by the ETDRS.[9]

The thickness of the retina is described as the distance from the retinal surface (ILM) to the photoreceptors' outer segment in Stratus OCT.[10] Based on ETDRS protocol, the macula is subdivided into nine regions of concentric rings, fovea being central 1mm (innermost ring), 3mm inner and 6mm outer ring, these are again subdivided into four segments.

The OCT system obtained macular thickness measurements in all nine segments (A1-A9) by three repeated scans. Mean macular thickness is an average of macular thickness calculated from all nine segments of the ETDRS map protocol.

Statistical Package for Social Sciences (SPSS) version 23.0 was used for the data analysis. Descriptive data was represented as Mean ± SD for quantitative variables (age, foveal thickness) and frequency and percentage for qualitative variable (gender).

An independent sample t-test was used for the mean comparison of macular thickness among gender. Pearson Correlation was applied to identify the relationship between age and macular thickness of layers. The *p*-value of ≤0.05 was set as the cut-off value for significance.

RESULTS

Out of 1704 healthy eyes of the study participants were examined with the age ranged between 10 to 80 years (mean 37.84 ± 15.9 years). There were 1221 (71.7%) males and 483 (28.3%) females. A2 area has a maximum mean macular thickness (298.24 ± 26.39 µm), and the A1 area has a minimum mean macular thickness (236.62 ± 31.29). The macular thickness of other areas was shown in Table-I.

Table-I: Background characteristics and macular layers thickness.

Variables	Values
Age	37.50 ± 15.75 years
Gender	
Male	1221 (71.7%)
Female	483 (28.3%)
Macular Layers Thickness (µm)	
A1	236.62 ± 31.29
A2	298.24 ± 26.39
A3	297.77 ± 18.84
A4	293.81 ± 18.20
A5	287.19 ± 16.89
A6	265.93 ± 22.14
A7	282.97 ± 22.74
A8	265.57 ± 25.41
A9	254.74 ± 22.51
Overall mean thickness	274.90 ± 15.18

The overall mean macular thickness of all nine layers was 274.90 ± 15.18 µm. Males had the mean macular thickness of 274.80 ± 14.62 µm, while females had 277.47 ± 14.59 µm. Macular thickness was found to be more in females than males (*p*=0.002) shown in Table-II.

Table-II: Gender wise mean of overall mean macular thickness.

Variables	Mean ± SD	*p*-value
Gender		
Male	274.80 ± 14.62 µm	0.02
Female	277.47 ± 14.59 µm	

Our study showed a statistically significant negative/inverse relationship between age and macular thickness in all the nine layers, as shown in Table-III.

Table-III: Relation between age and macular layers thickness.

Parameters	Correlation Co-Efficient	*p*-value
A1	0.259	0.001
A2	-0.184	0.001
A3	-0.215	0.001
A4	-0.353	0.001
A5	-0.171	0.001
A6	-0.255	0.001
A7	-0.271	0.001
A8	-0.110	0.001
A9	-0.163	0.001

DISCUSSION

Our study showed a significant reduction in macular thickness with age, and the female gender was seen to have greater thickness. This is the foremost normative study using Topcon SD-OCT and macular map protocol for macular thickness measurement from Pakistan. This study will help others perform further research to compare macula thickness with other populations and other OCT systems.

Several previous researches has been done on the histology of retina that showed the reduction in photoreceptors density occur with growing age. As the number of ganglion cells and pigment epithelial cells are lost per year of age, similarly, photoreceptors also decrease by 0.2% to 0.4% approximately.[11,12]

Optical coherence tomography (OCT), emerging light-based retinal imaging technology, provides cross-sectional images of structures such as the human retina.[13] Among all the newly available OCT machines, there is variability reported in the measurement of macular thickness by several studies.[14]

For macular thickness measurements, the IS/OS junction is selected as the outer retina in Stratus OCT,[15] whereas in SD-OCT, retinal pigment epithelium is selected as the outer retinal boundary. The spectral-domain OCT (SD-OCT) technology is now considered superior to time-domain OCT (TD-OCT) due to its quicker scanning speed, higher resolution and improved accuracy.[16]

Our study showed a significant decrease in macular thickness with age, consistent with various previous reports. Alamouti found a significant decrease in the total retinal thickness and the nerve fibre layer thickness with age. In that study, the data from the healthy eyes of 100 volunteers are included and analyzed. It was also concluded that on the reference plane, the influence of decrease in RNFL/Retinal thickness due to age is negligible.[17]

Our study results revealed a mean macular thickness of 274.90 ± 15.18. In a research study by Legarreta *et al,*[18] foveal thickness of 229.6 ± 24 mm was reported, while Sull *et al,*[19] got results using Topcon OCT, which showed a macular thickness of 231.6 ± 16 mm in normal subjects. These values are similar to the results of our study. Moreover, macular thickness decreased from centre to periphery in our study.

Demographic variations have been noted in studies previously. A notable difference in mean foveal thickness was observed by Grover *et al,*[20] between different races by utilizing the Spectralis SD-OCT system. Asefzadeh *et al,*[21] found the same results using Stratus OCT. Our results showed that females had greater macular thickness than males.

A crucial parameter for determining the functionality of an OCT system is measurement reproducibility. According to previous studies Topcon OCT system, due to its fast speed of scans, has shown good reproducibility than other conventional time-domain systems for measurement of macular thickness in normal and diseased states.[22]

LIMITATIONS OF STUDY

Limitations of our study include low refractive errors, a large range of age groups, and no variability in the race. Just the South Asian population was included. Studies that had variability in racial groups might have shown changes in macula thickness.

CONCLUSION

This study concluded a significant decrease in macular thickness with age. This is the first normative study using Topcon SD-OCT and macular map protocol for macular thickness measurement done in the Pakistani population.

Conflict of Interest: None.

Authors' Contribution

TBT: Data collection, drafting, WM: Conception, final approval, MF: Data collection, AA: Data analysis.

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