ORIGINAL ARTICLE

Macular Optical Coherence Tomography Findings in High Myopia

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Abstract

Background: ***When the eye is unable to accommodate the aberration, the point of conjugate focus is pushed anteriorly in front of the retina, resulting in myopia, a spherical refractive defect. Myopia is becoming more common; it now affects about 22.9% of the global population.***

Aim: ***To examine the macular area findings of optical coherence tomography (OCT) in cases of severe myopia and emmetropia, including retinal pigment epithelium thinning, central macular thickness (CMT), and choroidal neovascularization (if detected).***

Subjects and methods: ***This cross-sectional study was conducted on 20 eyes of persons with high myopia and 20 eyes with emmetropia as a control group at the departments of ophthalmology at Al-Azhar University Hospitals from May 2024 till January 2025.***

Results: ***The control group had a considerably higher macular thickness compared to the extreme myopic group (P<0.001). All patients of emmetropia had a mean CMT of 230.97±14.52 and were found to have no complications when examined with OCT. In contrast, the mean CMT for extreme myopia was 207.63±9.78. The control group had significantly better visual acuity than the extreme myopic group (P<0.001).***

Conclusion: ***Myopia is a common eye condition that has a high prevalence rate. Myopia is linked to a reduction in the overall macular thickness, as well as a thinning of the retina's various layers. OCT is a sensitive device for the detection of macular and choroidal changes associated with myopia.***

Keywords: High myopia; Optical coherence tomography

1. Introduction

People with myopia in both parents are more likely to have the condition themselves, indicating that heredity plays a role in the development of myopia. Population studies have shown a correlation between myopia development and education level, as well as the amount of time spent working close up; thus, activities that expose one to more optical blur.[1]

Low myopia, pathological high myopia, and simple myopia are the three main types of myopia. Commonly, an axial length greater than 26.5mm or minimal myopia (−6.00 SD) characterizes simple myopia. High axial myopia increases the risk of retinal degeneration, which can impair vision quality.[2]

Optical coherence tomography (OCT) is capable of taking many scans, average30 000 scans per second, decreasing the artifact that could be caused by eye movement, giving better resolution and less opportunity to miss any pathological lesion unintentionally.[3]

Regardless of the type of error—myopic or hyperopic—an emmetropic eye has an absolute value of less than 0.50 diopters as its spherical equivalent. Furthermore, its astigmatism can reach a maximum of 0.75 D.[4]

The purpose of this research was to examine the results of optical coherence tomography (OCT) in the macular region in patients with emmetropia and high myopia, specifically looking for signs of choroidal neovascularization, central macular thickness, and retinal pigment epithelium thinning.

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2. Patients and methods

This cross-sectional study was conducted on 20 eyes of persons with high myopia and 20 eyes with emmetropia as a control group at the departments of ophthalmology at Al-Azhar University Hospitals from May 2024 to January 2025.

Inclusion criteria:

Age between twenty-five and fifty years old, normal cornea, normal or myopic fundus, informed written consent from each participant patient after explanation of the study for them, myopia more than 6.00 D, and emmetropia with a spherical equivalent of less than 0.50 or maximum magnitude of astigmatism about 0.75 D.

Exclusion criteria:

Patients with dense media opacity, patients who had any ocular surgery in the same eye, patients with any ocular disease, including keratoconus, patients with systemic diseases as diabetes mellitus, and patients taking any ophthalmic eye drops, ointments, or injections as anti-glaucomatous medication.

Methods:

Each individual in this study was subjected to the following:

Full history talking, complete opthalmological examination, including: visual acuity assessment (UCVA and BCVA) by using Snellen chart in logMAR notation, dilated fundus examination by Volk non-contact Lense (90D) under mydriatic, intra ocular pressure recording using the Goldmann's applanation tonometry, slit lamp biomicroscopy for assessment of lid hygiene and presence of blepharitis, any areas of conjunctival scarring irregularity or hyperemia, corneal diseases or precence of cataract, and IOL Master: an optical biometer that measures axial length of eye using partial coherence interferometry at wavelength of 780nm.

SD-OCT:

After dilating the pupil with 1% tropicamide and 10% phenylephrine eye drops, the SD-OCT images were acquired using 3D-Optical Coherence Tomography Deep range imaging triton plus from Topcon, Japan. The macular cube 512×128 scan, which consists of 128 B-scans and 512 A-scans spanning a retinal area of 6.0×6.0mm, and HD 5-line raster scans were used to picture all people.

Image analysis:

We used a detachable hard drive to save all of the color fundus photographs, FFA, and OCT images in the JPEG format. Then, the two anonymous observers examined them side by side at the same resolution on the same computer screen. In the context of SD-OCT, myopic CNV was characterized as a hyper-reflective lesion above the retinal pigment epithelium-Bruch's membrane complex, which could have intraretinal fluid (IRF) or subretinal fluid (SRF) and retinal thickening in addition to being associated with an intraretinal hyper-reflective area.

3D-Optical Coherence Tomography was used to determine the thickness of the macula. Nikon, a Japanese company, specializes in long-range imaging systems. A protocol for rapid macular thickness scanning was employed. A 6 mm retinal thickness map analysis printout was used for the determination of macular thickness. The map was made up of nine measurements of sectorial thickness spread out over three concentric circles with 1, 3, and 6mm widths. The fovea was situated in the middle of the 1 mm circular area. The outer ring, or perifovea, was produced by the region bounded by the 6-millimeter and 3-millimeter circles, while the inner ring, or parafovea, was made by the area bounded by the 3-millimeter and 1-millimeter circles. Four additional quadrants were created from the perifovea and parafovea: Evaluation of the front, back, nose, and inferior regions.

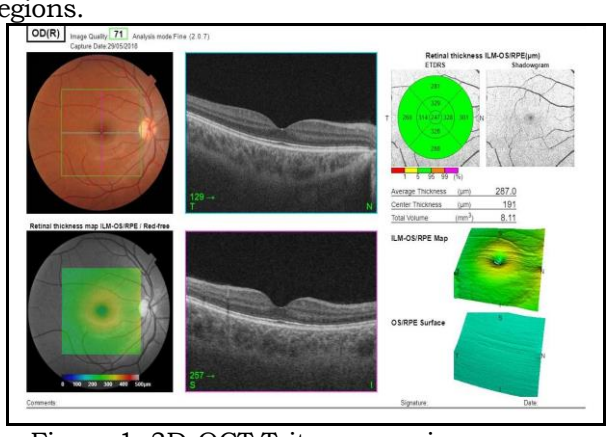

Figure 1. 3D-OCT Triton screening.

Statistical Analysis:

Statistical software for the social sciences (IBM Corp., 2017) was used to edit, code, and tabulate the gathered data. Armonk, New York: IBM Corp. (IBM SPSS Statistics for Windows, Version 25.0). Each parameter's data type informed the presentation and analysis of the resulting data. Numbers were represented using means, standard deviations (±SD), medians, and ranges. For data that was not numerical, the frequency and percentage were utilized. To determine whether there was a statistically significant difference between the two groups' means, the Student T Test was employed. To investigate the connection between two qualitative variables, the chi-square test was employed. If the p-value is less than 0.05 with a 95% confidence interval, it is deemed significant.

3. Results

Table 1. Comparison between high myopic group and emmetropia group regarding age and sex distribution.

VARIABLES	HIGH MYOPIA (N=20)	EMMETROPIA (N=20)	TEST	P-VALUE
AGE			1.32	0.74
MEAN ± SD	34.5±9.4	35.93±10.21		
RANGE	25-50	25-49		
GENDER			1.65	0.41
MALE	4(20%)	5(25%)		
FEMALE	16(80%)	15(75%)		

The following tests are used: independent t-test, chi-square test, non-significant (NS) when P>0.05, significant (S) when P<0.05.

There was a total of 40-eyes used in the study; 20 were classified as high myopic, and 20 served as controls. The high myopic group consisted of 16-females and 4-males, with an average age of 34.5±9.4 years and a range of 25-50 years., emmetropic group consist of 5-males (25% of the total) and 15 were females (75%). The average age of the control group was 35.93±10.21 years, with a range of 25– 49 years. There was insignificant difference between both studied groups as regard age and gender (p>0.05), (table 1).

Table 2. Comparison between high myopic group and emmetropia group.

VARIABLES	HIGH MYOPIA (N=20)	EMMETROPIA (N=20)	TEST	P-VALUE
AXIAL LENGTH			5.63	0.001*
MEAN ± SD	26.44±0.72	22.92±0.56		
RANGE	25.06-27.9	22.05-23.76		
IOP			7.78	0.04*
MEAN ± SD	14.8±1.77	13.87±1.66		
RANGE	12-18	11-18		

The control and high myopia groups differ in axial length and intraocular pressure (p<0.005). The high myopic group regarding axial length with an average 26.44±0.72 mm and a range of 25.06-27.9 mm and IOP with an average 14.8±1.77 mmhg and a range of 12-18mmhg. emmetropic group regarding axial length with an average 22.92±0.56 mm and a range of 22.05-23.76 mm and IOP with an average 13.87±1.66 mmhg and a range of 11-18 mmhg, (table 2; figures 2&3).

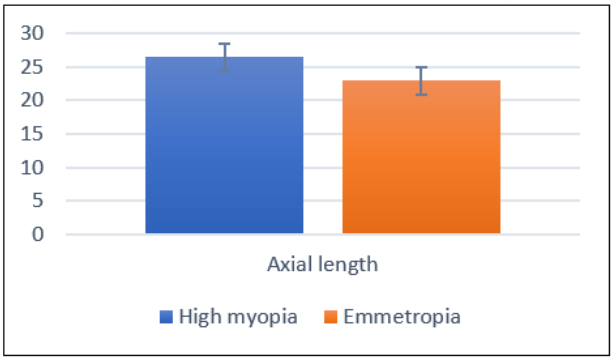

Figure 2. Examining the axial length of the high myopic and emmetropia groups.

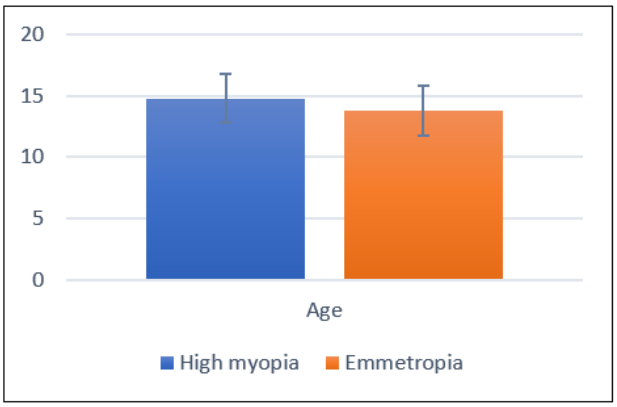

Figure 3. Examining intraocular pressure (IOP) in the high myopia and emmetropia groups.

Table 3. Examining the visual acuity of the high myopic and emmetropia groups.

VISUAL ACUITY	HIGH MYOPIA (N=20)	EMMETROPIA (N=20)	TEST	P-VALUE
UCVA			6.32	0.001*
MEAN ± SD	1.05±0.3	0.00		
RANGE	1.30-0.60	0.00		
BCVA			5.98	0.001*
MEAN ± SD	0.23±0.05	0.00		
RANGE	0.30-0.20	0.00		
SE			6.32	0.001*
MEAN ± SD	-8.69±1.4	-0.15±0.25		
RANGE	-11.5 – -6.25	-0.5-0.25		

The control group had significantly better visual acuity than the extreme myopic group (P<0.001). The high myopic group regarding UCVA with an average 1.05±0.3 and a range of 1.30-0.60, regarding BCVA with an average 0.23±0.05 and a range of 0.30-0.20, regarding SE with an average -8.69±1.4 and a range -11.5 – -6.25. Emmetropic group regarding UCVA with an average 0.00 and a range of 0.00, regarding BCVA with an average 0.00 and a range of 0.00, regarding SE with an average -0.15±0.25 and a range -0.5-0.25, (table 3).

Table 4. Examining the macular thickness in µm between the high myopic and emmetropia groups.

VARIABLES	HIGH MYOPIA (N=20)	EMMETROPIA (N=20)	TEST	P-VALUE
CENTRAL MACULAR THICKNESS (CMT)			6.25	0.002*
MEAN ± SD	207.63 9.78	230.97±14.52		
RANGE	150-400	180-410		
SUPERIOR QUADRANT			5.99	0.003*
MEAN ± SD	189.72±21.51	237.21±8.6		
RANGE	150-400	180-410		
INFERIOR QUADRANT			4.14	0.001*
MEAN ± SD	210.53±10.83	232.75±9.21		
RANGE	150-400	180-410		
NASAL QUADRANT			4.98	0.004*
MEAN ± SD	213.9±10.75	238.97±11.67		
RANGE	150-400	180-410		
TEMPORAL QUADRANT			6.37	0.001*
MEAN ± SD	189.21±21.52	211.8±114.29		
RANGE	150-400	180-410		
AVERAGE MACULAR THICKNESS			4.31	0.041*
MEAN ± SD	291.83±11.3	316.45±11.5		
RANGE	150-400	180-410		

The control group had a considerably higher macular thickness compared to the extreme myopic group (P<0.001). With no complications detected by OCT, the average CMT of emmetropia cases was 230.97±14.52, whereas the average CMT of high myopia was 207.63±9.78, (table 4;

figure 4).

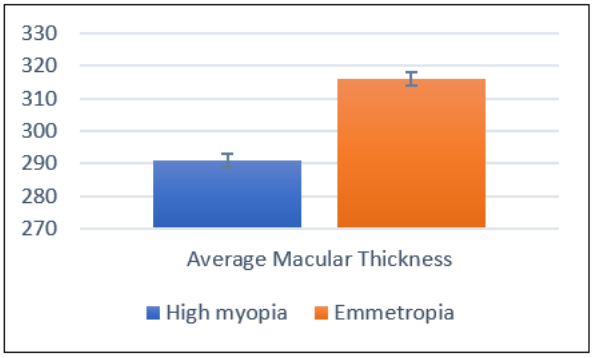

Figure 4. Comparison between high myopic group and emmetropia group regarding average macular thickness.

Table 5. Comparison between high myopic group and emmetropia group regarding retinal pigment epithelium thickness by µm.

VARIABLES	HIGH MYOPIA (N=20)	EMMETROPIA (N=20)	TEST	P-VALUE
RETINAL PIGMENT EPITHELIUM			6.32	0.001*
MEAN ± SD	16.2±2.5	18.6±2.6		
RANGE	10-40	10-40		
THINNING OF RPE			4.32	0.001*
YES	4(20%)	0(0%)		
NO	16(80%)	20(100%)		

Regarding Thinning of RPE, it was statistically significantly higher in the high myopic group when compared with the emmetropia group, (table 5; figure 5).

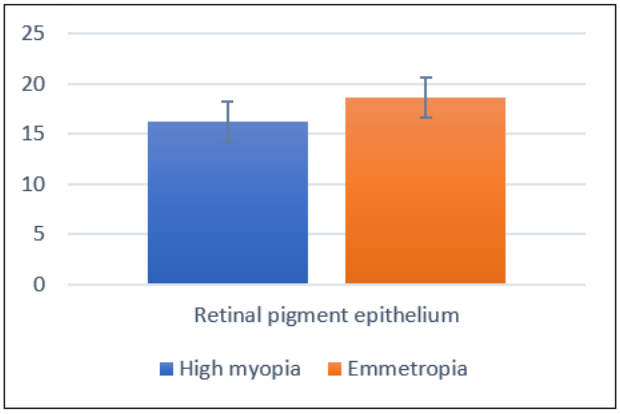

Figure 5. Evaluation of the retinal pigment epithelium in the high myopia and emmetropia groups.

Table 6. Studying choroidal neovascularization in two groups: those with extreme myopia and those with emmetropia.

VARIABLES	HIGH MYOPIA (N=20)	EMMETROPIA (N=20)	TEST	P-VALUE
CHOROIDAL NEOVASCULARIZATION (CNV)			4.78	0.002*
YES	3(15%)	0(0%)		
NO	17(85%)	20(100%)		

When comparing the groups with high myopia and emmetropia, the rate of choroidal neovascularization (CNV) was considerably greater in the former, (table 6; figure 6).

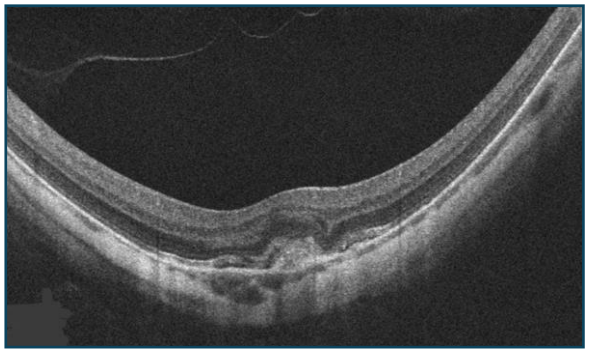

Figure 6. OCT of myopic CNV.

Table 7. Axial length and its relationship to other variables.

VARIABLES	R	P-VALUE
AGE	0.39	0.41
BCVA	-0.29	0.04*
CENTRAL MACULAR THICKNESS (CMT)	-0.47	0.001*
RETINAL PIGMENT EPITHELIUM	-0.53	0.02*
CHOROIDAL NEOVASCULARIZATION (CNV)	0.25	0.02*

Axis length, BCVA, CMT, and RPE were negatively correlated. The presence of choroidal neovascularization was positively correlated with axial length, (table 7).

4. Discussion

There has been a dramatic increase in the prevalence of myopia in recent years, making it a major concern in public health around the world. Myopia is becoming more common among young people. If your refractive error is less than -6.00 diopters, you have simple myopia, also called school myopia. A high degree of nearsightedness, defined as a spherical equivalent of greater than -6.00D and an axial length larger than 26mm, is indicative of high myopia.[5]

One of the main causes of excessive myopia is an abnormally long axial length. Pathological myopia, a major cause of legal blindness globally, is more common in those with extreme myopia and produces degenerative changes in the back of the eye, which lowers best-corrected visual acuity.[6]

In this study, there is a statistically significant difference($p<0.005$) in IOP and axial length between the high myopia and control groups.

Hasan et al.,[7] found that, with regard to the axial length, the control group had a much lower value than the high myopia group ($P<0.001$).

This was consistent with Min et al.,[8] The results demonstrated that the control group had a significantly lower mean AL (24±1.1) than the myopic group (27.5±1.1). Significant ($P<0.001$).

Agreed with Ucak et al.,[9] who showed that the mean AL in the control group was (23.09±0.79) mm, which was statistically lower than that for the high myopic group (26.97±0.79) mm ($p<0.001$).

Hasan et al.,[7] discovered that the two groups'

IOPs differed statistically (mean 14.8±1.77 in extreme myopia vs. 13.87±1.66 in emmetropia, p-value<0.05). The high myopia and control groups' IOPs differ statistically significantly (p<0.005).

Abd-AlNabi and Elsayed,[10] found that comparing the control group's mean IOP to that of the myopia group was 12.80±1.40 mmHg, which, in terms of statistics, was significantly lower than the IOP associated with the myopia group (15.33±2.04 mmHg; p<0.001 for both comparisons).

The results of this investigation verified that the control group had much better visual acuity than the high myopic group (P<0.001).

Hasan et al.,[7] discovered a drastically reduced visual acuity in the high myopic group compared to the control group (P<0.001).

Abd-AlNabi and Elsayed,[10] discovered that the spherical equivalent was noticeably lower in the myopic. Category (p<0.001). For both the VA and the BCVA, a statistically significant difference was found between the control group and the myopic group (p<0.001).

We demonstrated in this study that the control group had considerably thicker maculae than the extreme myopic group (P<0.001). In situations of emmetropia, the average CMT was 230.97±14.52, and there were no complications detected by OCT in any of the cases. In cases of extreme myopia, the average CMT was 207.63±9.78.

Abdellah et al.,[11] found that the high myopia group had a substantially lower central macular thickness (220.91±27.87μm) compared to the low myopia group (258.2 ±17.26μm), with a p-value of less than 0.0001. The statistically significant differences in parafoveal macular thickness across quadrants and in the thickness of the perifoveal macular quadrant suggested that high myopes were significantly thinner than age-matched emmetropes.

In research conducted by Malakar et al.,[12], in both the para and perifoveal regions, there was a noticeable decrease in macular thickness.

In the Munsamy et al.,[13] furthermore, all zones in the perifoveal region of high myopes showed statistically significant thinness, as did the superior, temporal, and inferior zones of the parafoveal region.

Jiang et al.,[14] found that a significant reduction in central macular thickness was observed in high myopic eyes (average ~200-250 μm). This thinning was attributed to stretching of the retina and choroid due to axial elongation, a hallmark of high myopia.

Our results showed that the high myopic group had significantly more RPE thinning than the emmetropia group when evaluated statistically.

Ye et al.,[15] discovered that the choroid and RPE were thinner in cases of extreme myopia compared to cases of emmetropia and simple myopia (P<0.05).

In this study, we found that, regarding CNV, it was statistically significantly higher in the high myopic group when compared with the emmetropic group.

Jiang et al.,[14] found that CNV was detected in a subset of high myopic eyes (10% of cases). CNV was associated with areas of RPE disruption and choroidal thinning, often presenting as subretinal fluid or hyperreflective lesions on OCT.

Su et al.,[16] investigated the choriocapillaris in myopic eyes using OCTA and discovered that, particularly in eyes without pathologic or degenerative myopia symptoms, the choriocapillaris had more impairment in high myopia eyes. According to reports, neovascularization can occur when blood circulation is inadequate.

Lu et al.,[17] determined that, in eyes with high myopia, choroidal neovascularization is largely caused by reduced choroidal vascular density.

Axis length, BCVA, CMT, and RPE were found to be significantly inversely related in this study, despite the fact that axial length and choroidal neovascularization were positively correlated.

Hassouna et al.,[18] found that there was a positive relationship between axial length and choroidal neovascularization and also a negative correlation with CMT.

El-Gazzar et al.,[19] found that there is significant negative correlation between AL and superficial macular vessel density.

4. Conclusion

Myopia is a common eye condition that has a high prevalence rate. Myopia is linked to a reduction in the overall macular thickness, as well as a thinning of the retina's various layers. OCT is a sensitive device for the detection of macular and choroidal changes associated with myopia.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

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