TITLE: INTER-OCULAR ASYMMETRY IN CHOROIDAL THICKNESS AND RETINAL SENSITIVITY IN HIGH MYOPIA

Abbreviated title: **Inter-ocular asymmetry in high myopia**

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KEY WORDS

Choroidal Thickness; High Myopia; Inter-ocular Asymmetry; Pathologic Myopia; Refractive Error; Retinal Sensitivity

SUMMARY STATEMENT

When compared with a control group of healthy eyes, patients with high myopia and without retinal abnormalities were found to present larger absolute inter-ocular differences in choroidal thickness and retinal sensitivity. These findings could aid in the early detection and management of pathological conditions associated with high myopia.

ABSTRACT

Purpose: To investigate the normal range of inter-ocular asymmetry in choroidal thickness and retinal sensitivity high myopia without ocular fundus manifestations and to determine the relationship between inter-ocular asymmetry and refractive error.

Methods: Forty-three patients (35.07 ± 13.31 years) with high myopia, and 45 healthy participants (39.9 ± 14.1 years) were administered an ocular coherence tomography and a microperimetry examination to determine choroidal thickness and retinal sensitivity at the foveal region and at 1, 2 and 3 mm, nasally, temporally, superiorly and inferiorly. Absolute inter-ocular differences were calculated to determine the normal range of asymmetry, in 95% confidence intervals.

Results: The choroid was thinner in the myopic group at all explored locations (all $p < 0.05$), with larger absolute inter-ocular differences in most of the choroidal locations under evaluation (all $p < 0.05$). Similarly, retinal sensitivity was reduced in the myopic group, although statistically significant differences were only encountered at the subfoveal location ($p = 0.001$). Retinal sensitivity asymmetry was found to increase with refractive error.

Conclusion: The expanded range of choroidal thickness and retinal sensitivity asymmetry found in high myopia in the absence of disease is of relevance when exploring these patients for early signs of ocular pathology.

INTRODUCTION

Pathologic myopia is one of the leading causes of blindness in the industrialized world, with significant social and economic impact.[1] The progressive axial elongation associated with pathologic myopia has been documented to result in structural changes in the ocular fundus, including thinning of the retina and choroid and posterior staphyloma which, in turn, may derive in a variety of ocular, and vision threatening complications, such as, choroidal neovascularization, lacquer cracks in Bruch's membrane and chorioretinal atrophy.[2-8]

Recent developments in optical coherence tomography (OCT) have provided researchers with high-resolution images and highly reproducible and repeatable measurements of the posterior pole, including the choroid, using the enhanced depth imaging (EDI) technique.[9-20] Examination of the choroid is particularly relevant in high myopia, as the earliest pathological changes appear in this region.[21] Similarly, the widespread use of microperimetry is allowing researchers and clinicians to explore the retinal sensitivity of the macula, as well as, fixation stability and eccentricity, that is, to monitor visual function.[22,23] This device is able to provide a precise retinal sensitivity map over the corresponding fundus image obtained with an infrared camera or a scanning laser ophthalmoscope (SLO). Few researchers have employed microperimetry to assess visual function in high myopia.[24-26] These authors have reported reduced retinal sensitivity in myopic than in emmetropic patients, with a negative correlation between the degree of myopia and the loss of sensitivity. However, the relationship between structural changes and visual function in myopia remains elusive and controversial, and once other confounding variables are considered, only weak

correlations are found between choroidal thickness, retinal sensitivity and visual acuity[24,27-30], albeit there may be a threshold level of choroidal thinning beyond which visual function is compromised[28,29].

In light of the critical relevance of the prompt detection of any pathological changes associated with high myopia, and given that structural changes in the choroid precede visual manifestations[31], previous studies have aimed to determine the normal thresholds of inter-ocular asymmetry, whereupon differences in choroidal thickness beyond these thresholds may be suggestive of early stages of choroidal atrophy. However, as far as our literature review has disclosed, these studies have only explored healthy eyes[11,32]. It may be hypothesized that highly-myopic eyes, even in the absence of complications, may present a different range of inter-ocular asymmetry. Therefore, it was the primary objective of the present cross-sectional study to assess the threshold of inter-ocular asymmetry in choroidal thickness, as well as, in retinal sensitivity, in a sample of patients with high myopia without ocular complications and to compare these results with those of an age-matched control group of healthy subjects. As a secondary objective, within the myopic group, the relationship between the degree of structural and functional asymmetry and the level of refractive error was determined.

METHODS

Subjects

Forty-three patients with high myopia participated in this study. Patients were selected consecutively from those attending an optometric practice (Optipunt Figueres, Spain) between April 2014 and June 2016 for routine visual examination. Patients were included if they had a spherical equivalent refractive error ≥ -6.00 D, and anisometropia ≤ 0.50 D. Only patients without retinal and choroidal complications were included in the study. Therefore, patients were excluded if they presented with any ocular fundus pathology, such as, but not limited to, choroidal neovascularization, foveoschisis, macular hole, diabetic retinopathy, posterior uveitis, drusen or age-related macular degeneration, as were those with a history of ocular trauma, glaucoma, amblyopia, ocular or refractive surgery.

For comparison purposes, an age-matched control group of 45 normal patients was selected from those attending the same centre. Inclusion criteria for the control group were spherical equivalent refraction between +4.00 D and -3.00 D, anisometropia ≤ 0.50 D, distance corrected visual acuity (DCVA) of 0.0 logMAR (20/20) or better, and intraocular pressure < 21 mmHg. Patients with a history of ocular trauma or pathology, ocular or refractive surgery, diabetes mellitus or any other systemic disease with potential ocular manifestations, and those with first-degree relatives diagnosed with glaucoma or retinal disease were excluded from the study.

For both the high myopia and control group, patients without clear ocular media or without central fixation were also excluded, as were those failing to understand or cooperate during OCT or microperimetry measurements.

All patients were provided with written information regarding the procedures and the aim of the study and informed consent was obtained from all participants or from a parent or legal guardian in those patients still underage. The study was conducted in accordance with the Declaration of Helsinki tenets of 1975 (as revised in Tokyo in 2004) and received the approval of the Ethics Review Board of the Hospital Universitari Mutua de Terrassa, Spain.

Choroidal thickness evaluation

A spectral-domain 3D-OCT-2000 (Topcon Corporation, Tokyo, Japan) with enhanced depth imaging (EDI) was used to measure choroidal thickness at the subfoveal region and at 1 mm, 2 mm and 3 mm from the fovea, nasally, temporally, superiorly and inferiorly. Choroidal thickness was defined as the distance between the retinal pigment epithelium and the inner margin of the sclera (choroidal-scleral interface), seen as a hyper-reflective line behind the large vessel layer of the choroid. A calliper was employed to measure this distance manually. All measurements were performed by two independent experienced examiners (A. Z. and Z. A.), whereupon the average of the two measurements was used for statistical analysis. Measurements were repeated by a third examiner (M.A.Z.) if the difference between the two measurements was over 15%.

Retinal sensitivity evaluation

Microperimetry was performed with a MAIA microperimeter (Macular Analyzer Integrity Assessment, CenterVue, Padova, Italy). This instrument uses a combination of scanning laser ophthalmoscopy and static perimetry to provide a maximum illumination level of 318.47 cd/m^2, which may be attenuated up to 36 dB, in 1 dB steps. Results are classified as normal if over 27 dB, suspect when they fall between 26 and 27 dB and anomalous if under 26 dB. Measurements were performed with the "Expert Exam" mode which utilizes a 4-2-1 staircase strategy to present 37 stimuli in three concentric circles of 2, 6 and 10 degrees of diameter, corresponding, approximately, to 1 mm, 2 mm and 3 mm, respectively, from the center of the macula. Duration of the stimulus is 200 ms, with the whole exam lasting about 5 minutes per eye.

The MAIA microperimeter also allows for the evaluation of fixation by using high speed eye trackers (25 Hz) to register the fixation pattern, whereupon the device calculates fixation indexes to determine the percentage of fixation points inside two circles of pre-defined diameter. Fixation data of our sample of patients shall not be presented and discussed in this article.

Contact lenses were employed during microperimetry in those patients with refractive errors > 15.00 D. For those with refractive error less than 15.00 D the device automatically conducts the required range of focus adjustments. All microperimetry examinations were performed in a dim-illuminated room without the need for pupil dilation and only after the patients were comfortable with the procedure and instrumentation.

Procedure

Following a comprehensive case history, patients underwent a complete optometric examination, including non-contact air-puff tonometry. Non-cycloplegic refraction was performed and monocular DCVA was assessed with the retro-illuminated Early Treatment Diabetic Retinopathy Study (ETDRS) chart (Lighthouse International, NY). The chart was presented at a distance of 4 m and visual acuity values were recorded in logMAR units.

Ocular fundus and cross-sectional macular images were captured with the OCT device and sent to a medical team of retinal experts (OPTretina S.L., Barcelona, Spain) to identify and exclude patients with retinal pathologies, in accordance with the predefined inclusion/exclusion criteria.

All patients underwent microperimetry and OCT examination consecutively, allowing for rest between examinations and for adaptation to the dim-light prior to microperimetry. In all instances microperimetry was performed before OCT to avoid any unwanted after-image effect of the strong flash of light employed by the OCT for image capture. During each procedure eyes were examined in random order. All measurements were conducted approximately at the same time of day to avoid the possible effect of diurnal variations in choroidal thickness[33].

Data analysis

Statistical analysis was conducted with the statistical package IBM SPSS, V. 19 (IBM, Inc, USA) for Windows. Data were evaluated for normality with the Kolmogorov-

Smirnov test, which revealed that all variables under examination followed a normal distribution. Therefore, descriptive statistics is presented in terms of mean and standard deviation (SD). In addition, the 95% Confidence Interval (95% CI) was calculated to define the thresholds for normal inter-ocular asymmetry of the various anatomical and functional parameters. For this purpose, the absolute values of inter-ocular asymmetry were considered, rather than the relative values. Inferential statistics were conducted with the Student t-test for matched pairs when comparing data from right and left eyes or with the Student t-test for unmatched pairs if data belonged to different study groups (such as control and high myopia groups). Finally, in order to investigate the possible association between absolute inter-ocular differences and refractive error, in the myopia group, the Pearson correlation test was employed. Correlations were defined as weak if $0.4 \leq r < 0.6$, moderate if $0.6 \leq r < 0.8$ and strong if $r \geq 0.8$. A p-value <0.05 was considered as the threshold for statistical significance.

RESULTS

Sample demographics

Forty-three subjects (15 females; 28 males) were enrolled in the myopic group, with an age of 35.07 ± 13.31 years (range from 13 to 60 years). Refractive error was -9.11 ± 3.74 D (range from -17.30 D to -6.00 D) in the right eye (RE) and -9.08 ± 3.67 D (range from -17.00 D to -6.00 D) in the left eye (LE) ($p = 0.850$). Forty-five subjects (23 females; 22 males) were enrolled in the control group, with an age of 39.9 ± 14.1 years (range from 16 to 68 years). Refractive error for the control group was -0.23 ± 0.81 D (range from -2.75 D to +1.00 D) in the RE and -0.21 ± 0.75 D (range from -2.75 D to +1.25 D) in the LE ($p = 0.730$). Both in the myopia and control group, no statistically significant inter-ocular differences were found in CDVA. Besides, no statistically significant differences in age were encountered between the groups.

Choroidal thickness evaluation

Table 1 displays a summary of mean choroidal thickness at each of the locations and quadrants under examination for both the high myopia and control groups. Results are presented as mean ± SD for right and left eyes, and the outcome of the Student t-test for matched pairs for each group is also shown to highlight the statistical significance of the encountered inter-ocular differences. In the control group, statistically significant differences between the RE and LE were found only at 1 mm nasally (277.03 ± 13.74 µm in RE; 278.06 ± 13.97 µm in LE; $p < 0.001$) and at 2 mm temporally (224.20 ± 14.61 µm in RE; 231.09 ± 14.30 µm in LE; $p = 0.013$). For both eyes, mean choroidal thickness values were larger subfoveally, and decreased progressively towards the

periphery. Conversely, in the high myopia group, statistically significant differences between both eyes were encountered only at 3 mm nasally (152.65 ± 46.91 μm in RE; 210.60 ± 47.72 μm in LE; $p < 0.001$) and at 3 mm temporally (195.07 ± 44.43 μm in RE; 153.49 ± 45.67 μm in LE; $p < 0.001$). For both eyes, mean choroidal thickness values were larger at the 3 mm ring, followed by the 1 mm ring and 2 mm ring. The choroid was thinnest subfoveally. Overall, the choroid was thinner in the myopic than in the control group at all explored locations (all $p < 0.05$).

Absolute inter-ocular differences in choroidal thickness, described as mean ± SD (95% CI) are presented in **Table 2**. The non-matched pairs Student t-test was used to analyze the differences between the myopic and control groups in terms of absolute inter-ocular differences. Inter-ocular differences were larger in the myopic group in most of the choroidal locations under evaluation (all $p < 0.05$).

Retinal sensitivity evaluation

Table 3 displays a summary of retinal sensitivity values for both groups. For each eye, results are presented as mean ± SD, and the outcome of the Student t-test for matched pairs to explore the statistical significance of the inter-ocular differences is also shown. In the control group, statistically significant differences were found between RE and LE in overall mean sensitivity values (27.50 ± 1.71 dB in RE; 28.07 ± 1.25 dB in LE; $p = 0.008$), as well as at several peripheral locations. Retinal sensitivity gradually decreased towards the periphery, with the lowest values at 3 mm temporally in both eyes. Similarly, statistically significant inter-ocular differences were found in the myopic group, both in overall mean retinal sensitivity values (27.10 ± 3.61 dB in RE;

27.91 ± 2.50 dB in LE; p = 0.018) and at several central and peripheral locations. In the myopic group, mean retinal sensitivity was lowest at the macula in both eyes, and progressively increased at the 3 mm, 1 mm and 2 mm locations in the RE and at the 3 mm, 2 mm and 1 mm locations in the LE. Overall, albeit retinal sensitivity was better in the control group, differences only reached statistical significance at the central location (p = 0.001).

Table 4 displays a summary of absolute inter-ocular differences in retinal sensitivity for both groups in terms of mean ± SD (95% CI). In general, inter-ocular differences were larger in the myopic group than in the control group, although statistically significant differences were only encountered at the central location (p = 0.001).

Inter-ocular differences and refractive error

A Pearson coefficient of correlation test was employed to investigate the association between mean refractive error and absolute inter-ocular differences in both choroidal thickness and retinal sensitivity in the myopic group. The results of this analysis are shown in **Table 5**. No statistically significant correlations were found between choroidal thickness asymmetry at any of the explored locations and refractive error, with the exception of at the 1 mm ring, superiorly. Conversely, statistically significant moderate negative correlations were found between refractive error and absolute inter-ocular differences in retinal sensitivity at most of the locations under examination, particularly towards the centre of the retina, that is, retinal sensitivity asymmetry was found to increase with refractive error.

DISCUSSION

It is estimated that by 2050 approximately 1 billion people worldwide will have high myopia[34]. However, not all patients with high myopia will develop complications leading to pathologic myopia. Indeed, in a longitudinal study of 61 months, Vongphanit and co-workers reported that only 17.4% of their 67 eyes with high myopia developed myopic retinopathy[35]. One of the complications of pathologic myopia is posterior staphyloma, in which the retina and choroid are abnormally stretched, leading to anatomical damage and visual impairment. Another complication is diffuse atrophy, which presents as a local area of choroidal thinning but relatively intact outer retinal structures, that is, without initial visual involvement. Both complications may appear unilaterally, highlighting the clinical relevance of an early detection through the exploration of choroidal thickness and retinal sensitivity[36]. The main purpose of the present research was to describe the normal range of inter-ocular asymmetry in choroidal thickness and retinal sensitivity in a sample of patients with high myopia without complications, that is, to define the threshold beyond which early signs of pathologic myopia complications may be detected and preventive treatment strategies implemented.

Regarding choroidal thickness, the present findings are in agreement with previous reports describing a thinner choroid in high myopia than in healthy eyes, both subfoveally and in different peripheral locations[2,20,29,30,37]. Besides, whereas in the control group the thickest choroid was found subfoveally, in the myopic group this area was the thinnest. Similarly, differences were observed between the myopic and healthy groups in the distribution of choroidal thickness across the different quadrants

and peripheral rings under examination. These findings are also in general agreement with published literature, although differences in sample demographics and range of refractive errors prevent a direct comparison of absolute choroidal thickness values with previous research. In effect, in the Beijing Eye Study of 2011, in which 3468 were examined with spectral-domain OCT, in myopic subjects with refractive error over 1.00 D subfoveal choroidal thickness was found to decrease by 15 µm (95% CI 11.9 to 18.5 µm) for every further increase in refractive error of 1.00 D[38].

Interestingly, absolute inter-ocular differences in choroidal thickness were very small for the control group, in agreement with previous reports documenting differences under 10 µm at the subfoveal region[11,32]. Inter-ocular differences were larger in the myopic, particularly at the 3 mm ring, nasally (57.95 ± 51.80 µm in the myopic group versus 2.34 ± 20.19 µm in the control group) and temporally (41.58 ± 56.81 µm in the myopic group versus 0.66 ± 22.62 µm in the control group). Overall, inter-ocular asymmetry was at least twice in myopia than in healthy eyes. Within the myopic group, no statistically significant correlations were found between refractive error and choroidal thickness asymmetry.

In terms of retinal sensitivity, very few studies have explored visual function in high myopia, documenting a reduction in retinal sensitivity, more pronounced with increasing refractive error[24-26]. Reduced retinal sensitivity was found in our sample of myopic patients, when compared with the control group, albeit these differences only reached statistical significance subfoveally, with mean values of 24.84 ± 4.58 dB in RE and 26.05 ± 3.60 dB in LE for the myopic group and 27.74 ± 2.51 dB in RE and 28.09 ± 2.36 dB in LE for the control group. It must be noted that, although many of the

locations under study presented suspect retinal sensitivity values (between 26 and 27 dB), only at the subfoveal region in the RE was the mean value of sensitivity anomalous. However, as evidenced by the large inter-subject variability (large SD values), when considering individual rather than mean values, some of the patients had retinal sensitivity values well below the threshold of normality, even in the absence of ocular fundus disease.

Finally, regarding inter-ocular differences in retinal sensitivity, in general a larger asymmetry was encountered in the myopic group, although differences only reached statistical significance at the subfoveal region, with inter-ocular differences decreasing towards the periphery. Overall, in myopia inter-ocular asymmetry was approximately twice that of healthy eyes. Besides, retinal sensitivity asymmetry was found to increase with refractive error, and statistically significant correlations were found at most of the areas under study. These findings give support to the need to consider refractive error not only in the interpretation of retinal sensitivity nomograms[24], but also when assessing inter-ocular asymmetry.

The present study was not devoid of limitations. Firstly, many potential participants with myopia over -10.00 D had to be excluded due to the observation of ocular fundus complications characteristic of pathologic myopia. Therefore, although all patients in the high myopia group had refractive errors over -6.00 D, most of them were clustered in the range between -6.00 D and -10.00D, that is, they could be considered to represent the low end of high myopia. Secondly, as also noted by previous authors[30], the use of manual callipers to perform choroidal thickness measurements may not be a very precise approach, particularly when distances are small, as was the case in some

myopic eyes. Thirdly, as axial length data was not available for all patients, the documented correlation between axial length and choroidal thickness[2] could not be explored to determine the extent of the correlation between inter-ocular asymmetry in choroidal thickness and axial length, as compared with refractive error. Finally, even though none of the patients included in the study had any abnormality of the ocular fundus, given the cross-sectional design of this study, it can not be ruled out that the larger inter-ocular differences encountered in some of our patients were indicative of earlier stages of disease. Patients from the myopic group were scheduled for follow-up visits to explore the possible onset of pathologic myopia in the future.

In conclusion, as far as we know, this is the first study investigating inter-ocular differences in choroidal thickness and retinal sensitivity in high myopia in the absence of ocular complications. The present findings revealed an expanded range of absolute inter-ocular differences in the high myopia group, when compared with the control group and with published literature (when available). Given the critical importance of an early detection and treatment of pathological conditions such as posterior staphyloma and chorioretinal atrophy, we believe these results to be relevant to eye care providers to aid in their diagnosis and to researchers to provide further insight into the fine line separating high from pathologic myopia.

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Table 1. Mean choroidal thickness at each of the locations and quadrants under examination (N: Nasal; T: Temporal; S: Superior; I: Inferior) for myopia and control groups. Results are presented as mean ± SD for right (RE) and left (LE) eyes, and the outcome of the Student t-test for matched pairs for each group is also shown. P-values in bold denote statistically significant inter-ocular differences.

	CONTROL GROUP					MYOPIA GROUP				
Choroidal Thickness (µm)	**RE**		**LE**			**RE**		**LE**		
	Mean	**SD**	**Mean**	**SD**	**p**	**Mean**	**SD**	**Mean**	**SD**	**p**
Central	307.31	13.77	309.80	18.12	0.478	174.50	62.99	171.67	56.45	0.604
1 mm N	277.03	13.74	278.06	13.97	**<0.001**	163.93	52.34	153.38	51.96	0.095
1 mm T	252.51	16.20	254.23	17.61	0.668	187.36	66.10	183.30	51.32	0.565
1 mm S	212.74	19.14	214.70	24.13	0.695	199.90	62.97	189.59	57.42	0.130
1 mm I	285.60	11.32	290.71	14.75	0.139	190.20	54.26	188.94	51.22	0.841
2 mm N	263.77	10.64	268.91	15.52	0.108	128.98	50.82	134.28	67.25	0.510
2 mm T	224.20	14.61	231.09	14.30	**0.013**	183.91	59.61	183.02	52.57	0.914
2 mm S	301.60	20.52	304.40	18.57	0.489	206.57	57.27	198.56	54.12	0.188
2 mm I	259.00	14.45	256.71	18.62	0.573	187.93	55.29	188.62	51.96	0.909
3 mm N	219.26	17.20	221.60	19.55	0.497	152.65	46.91	210.60	47.72	**<0.001**
3 mm T	296.23	13.19	296.89	17.52	0.865	195.07	44.43	153.49	45.67	**<0.001**
3 mm S	254.83	13.54	255.66	17.33	0.826	212.98	48.68	212.00	40.49	0.872
3 mm I	221.63	17.95	216.34	13.82	0.132	197.98	47.14	199.33	44.76	0.824
Mean of 1 mm ring	290.14	10.58	292.54	11.60	0.347	185.37	54.91	178.83	48.31	0.167
Mean of 2 mm ring	257.55	8.86	258.90	9.87	0.539	176.86	46.93	176.15	45.10	0.860
Mean of 3 mm ring	219.48	11.61	220.96	13.41	0.417	189.69	31.49	193.88	32.06	0.249

Table 2. Absolute inter-ocular differences in choroidal thickness in mean ± SD (95% CI) at each of the locations and quadrants under examination (N: Nasal; T: Temporal; S: Superior; I: Inferior) for myopia and control groups. The results of the non-matched pairs Student t-test are shown. P-values in bold denote statistically significant differences between the myopic and control groups in terms of absolute inter-ocular differences.

Absolute inter-ocular difference in choroidal thickness (µm)	CONTROL GROUP				MYOPIA GROUP				p
	Mean	SD	95% CI		Mean	SD	95% CI		p
Central	2.49	20.52	-37.73	42.71	2.83	35.48	-66.71	72.37	**0.001**
1 mm N	1.03	19.66	-37.50	39.56	10.55	40.46	-68.75	89.85	**0.001**
1 mm T	1.71	23.41	-44.17	47.59	4.06	45.88	-85.86	93.98	**<0.001**
1 mm S	1.94	29.03	-54.96	58.84	10.30	43.77	-75.49	96.09	**0.004**
1 mm I	5.11	19.99	-34.07	44.29	1.26	40.68	-78.47	80.99	**0.047**
2 mm N	5.14	18.44	-31.00	41.28	5.30	52.32	-97.25	107.85	**0.002**
2 mm T	6.89	15.57	-23.63	37.41	0.88	53.61	-104.20	105.96	**<0.001**
2 mm S	2.8	23.70	-43.65	49.25	8.01	39.24	-68.90	84.92	**0.007**
2 mm I	2.29	23.77	-44.30	48.88	0.69	39.34	-76.42	77.80	**0.011**
3 mm N	2.34	20.19	-37.23	41.91	57.95	51.8	-43.58	159.48	**<0.001**
3 mm T	0.66	22.62	-43.68	45.00	41.58	56.81	-69.77	152.93	**<0.001**
3 mm S	0.83	22.11	-42.51	44.17	0.98	39.63	-76.69	78.65	**0.014**
3 mm I	5.29	20.24	-34.38	44.96	1.35	39.46	-75.99	78.69	**0.001**
Mean of 1 mm ring	2.4	14.86	-26.73	31.53	6.54	30.51	-53.26	66.34	**0.002**
Mean of 2 mm ring	1.35	12.86	-23.86	26.56	0.73	26.47	-51.15	52.61	**<0.001**
Mean of 3 mm ring	1.47	10.62	-19.35	22.29	4.18	23.47	-41.82	50.18	**<0.001**

Table 3. Mean retinal sensitivity at each of the locations and quadrants under examination (N: Nasal; T: Temporal; S: Superior; I: Inferior) for myopia and control groups. Results are presented as mean ± SD for right (RE) and left (LE) eyes. The outcome of the Student t-test for matched pairs for each group is also shown. P-values in bold denote statistically significant inter-ocular differences.

	CONTROL GROUP					MYOPIA GROUP				
Retinal sensitivity (dB)	**RE**		**LE**			**RE**		**LE**		
	Mean	**SD**	**Mean**	**SD**	**p**	**Mean**	**SD**	**Mean**	**SD**	**p**
Central	27.74	2.51	28.09	2.36	0.452	24.84	4.58	26.05	3.60	**0.029**
1 mm N	27.42	1.86	28.16	1.64	**0.031**	27.21	4.39	28.76	2.16	**0.003**
1 mm T	28.37	1.79	28.78	1.63	0.198	26.92	4.89	28.46	2.43	**0.010**
1 mm S	28.51	2.14	29.07	1.70	0.098	27.64	3.64	28.12	2.93	0.272
1 mm I	27.98	1.96	28.34	1.55	0.320	26.89	3.96	28.03	2.20	0.034
2 mm N	28.03	2.10	28.48	1.26	0.146	27.15	4.84	28.62	2.46	**0.006**
2 mm T	27.31	1.62	27.75	1.58	0.112	26.77	3.25	27.80	1.99	**0.004**
2 mm S	27.44	2.24	28.41	1.52	**0.003**	27.54	2.43	27.88	3.82	0.402
2 mm I	27.69	2.10	28.30	1.30	0.056	27.29	2.85	28.07	2.56	**0.023**
3 mm N	26.91	1.79	27.78	1.28	**0.002**	26.31	4.63	27.54	4.38	**<0.001**
3 mm T	26.54	1.92	26.74	1.70	0.525	26.13	2.95	26.76	2.83	**0.046**
3 mm S	26.69	2.07	27.66	1.52	**0.002**	26.96	3.59	27.02	3.57	0.853
3 mm I	26.84	1.97	27.55	1.71	**0.007**	26.86	2.37	27.38	1.97	0.107
Mean of 1 mm ring	28.04	1.71	28.56	1.46	**0.048**	27.18	4.02	28.44	2.12	**0.007**
Mean of 2 mm ring	27.72	1.91	28.24	1.21	**0.041**	27.25	3.15	28.14	2.44	**0.001**
Mean of 3 mm ring	26.70	1.72	27.43	1.29	**0.002**	26.56	3.21	27.30	2.93	**0.004**
Overall mean	27.50	1.71	28.07	1.25	**0.008**	27.10	3.61	27.91	2.50	**0.018**

Table 4. Absolute inter-ocular differences in retinal sensitivity in mean ± SD (95% CI) at each of the locations and quadrants under examination (N: Nasal; T: Temporal; S: Superior; I: Inferior) for myopia and control groups. The results of the non-matched pairs Student t-test are shown. P-values in bold denote statistically significant differences between the myopic and control groups in terms of absolute inter-ocular differences.

Absolute inter-ocular difference in retinal sensitivity (dB)	**CONTROL GROUP**				**MYOPIA GROUP**				**p**
	Mean	**SD**	**95% CI**		**Mean**	**SD**	**95% CI**		**p**
Central	0.34	2.67	-4.89	5.57	1.21	3.51	-5.67	8.09	**0.001**
1 mm N	0.74	1.94	-3.06	4.54	1.55	3.23	-4.78	7.88	0.790
1 mm T	0.41	1.84	-3.20	4.02	1.55	3.74	-5.78	8.88	0.099
1 mm S	0.57	1.97	-3.29	4.43	0.49	2.87	-5.14	6.12	0.215
1 mm I	0.36	2.11	-3.78	4.50	1.14	3.41	-5.54	7.82	0.142
2 mm N	0.47	1.77	-3.00	3.94	1.47	3.32	-5.04	7.98	0.319
2 mm T	0.44	1.6	-2.70	3.58	1.03	2.23	-3.34	5.40	0.371
2 mm S	0.97	1.82	-2.60	4.54	0.34	2.63	-4.81	5.49	0.853
2 mm I	0.62	1.84	-2.99	4.23	0.78	2.15	-3.43	4.99	0.499
3 mm N	0.87	1.53	-2.13	3.87	1.23	2.03	-2.75	5.21	0.468
3 mm T	0.2	1.87	-3.47	3.87	0.63	2.02	-3.33	4.59	0.482
3 mm S	0.98	1.76	-2.47	4.43	0.05	1.88	-3.63	3.73	0.687
3 mm I	0.71	1.47	-2.17	3.59	0.52	2.06	-3.52	4.56	0.960
Mean of 1 mm ring	0.52	1.5	-2.42	3.46	1.26	2.91	-4.44	6.96	0.244
Mean of 2 mm ring	0.51	1.43	-2.29	3.31	0.89	1.60	-2.25	4.03	0.441
Mean of 3 mm ring	0.76	1.34	-1.87	3.39	0.74	1.57	-2.34	3.82	0.850
Overall mean	0.6	1.26	-1.87	3.07	0.81	2.15	-3.40	5.02	0.578

Table 5. Correlation analysis of the association between mean refractive error and absolute inter-ocular differences in both choroidal thickness and retinal sensitivity in the myopic group. Correlation coefficient (r) and statistical significance (p) are shown), with values in bold denoting statistical significance.

Absolute inter-ocular difference in choroidal thickness (µm)	r	p	Absolute inter-ocular difference in retinal sensitivity (dB)	r	p
Central	0.189	0.202	Central	**-0.345**	**0.018**
1 mm N	0.113	0.448	1 mm N	**-0.578**	**<0.001**
1 mm T	-0.111	0.457	1 mm T	**-0.738**	**<0.001**
1 mm S	**-0.441**	**0.002**	1 mm S	-0.228	0.123
1 mm I	-0.108	0.471	1 mm I	**-0.491**	**<0.001**
2 mm N	-0.166	0.265	2 mm N	**-0.633**	**<0.001**
2 mm T	0.027	0.856	2 mm T	**-0.413**	**0.004**
2 mm S	-0.062	0.681	2 mm S	**-0.501**	**<0.001**
2 mm I	0.166	0.264	2 mm I	0.002	0.989
3 mm N	0.164	0.270	3 mm N	-0.120	0.423
3 mm T	-0.276	0.060	3 mm T	-0.074	0.619
3 mm S	-0.223	0.131	3 mm S	0.144	0.334
3 mm I	-0.010	0.949	3 mm I	-0.285	0.052
Mean of 1 mm ring	0.120	0.421	Mean of 1 mm ring	**-0.545**	**<0.001**
Mean of 2 mm ring	0.021	0.888	Mean of 2 mm ring	-0.226	0.127
Mean of 3 mm ring	-0.249	0.091	Mean of 3 mm ring	-0.079	0.600
			Overall mean	**-0.304**	**0.038**