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Retinal and Choroidal thickness in myopic children: a retrospective study

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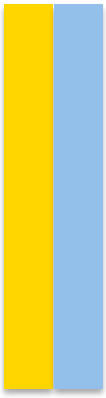

Retinal and Choroidal thickness in myopic children: a retrospective study

Dissertação de candidatura ao grau de Mestre em Medicina, submetida ao Instituto de Ciências Biomédicas Abel Salazar – Universidade do Porto

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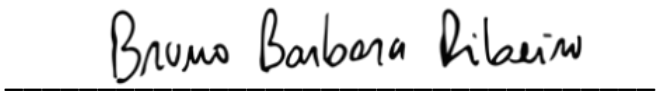

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Dedicatória

Ao meu pai, minha mãe, meu irmão, irmã, minha cunhada, minha futura esposa e a restante família, obrigado por me terem acompanhado todo este percurso académico exaustivo, tive o luxo de ser o primeiro da família a completar a universidade e sem o vosso suporte até agora nunca iria ser possível.

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Abstract

Purpose: To analyze and compare subfoveal choroidal thickness (SCT), retinal central subfield thickness (CST) and axial length (AL) in children´s myopic versus nonmyopic eyes.

Methods: Forty-four eyes were included in this retrospective study from twenty-two children whose ages varied between 6 and 11 years of age (mean age 9.72 ±1.46 years). Patients were classified as myopic or non-myopic, considering the spherical equivalent (SE) refractive error (myopic if SE ≤-0,75 Diopters (D); non-myopic if SE between +1,00 D and -0,50D). Older or younger patients and patients with astigmatism higher than 1,00 D were excluded.

All children underwent an extensive ophthalmic examination including non-cycloplegic refraction, optic biometry, and spectral domain optical coherence tomography (SD-OCT). Twenty eyes were myopic with mean SE of -2.43 ± 1.1 D and twenty-four eyes were emmetropic (mean SE 0.00 D). Normal distribution of the results was tested with a Kolmogorov Smirnov test; independent student´s t test, Mann-Whitney U test and repeated measures analysis of variance (RMANOVA) were used to analyze continuous variables. Pearson chi square was then used for comparison of categorical variables.

Results: Subfoveal choroidal thickness was significantly thinner in myopes (mean 248±45 µm) when compared to emmetropic children (mean 321±26 µm) ($p<0.001$). There was no significant difference in retinal central subfield thickness between the myopic (median 217±37 µm) and the emmetropic groups (median 217±19 µm) ($p=0.944$). Axial Length was significantly longer in myopic children (mean 24.47±0.6 mm) than emmetropic children (mean 23.23±0.4 mm) ($p<0.001$).

Conclusion: Choroidal thickness, particularly SCT, was found to be thinner in myopic children when compared to emmetropic children while there were no significant differences in retinal central subfield thickness between the two groups. These results suggest that choroid might play an important role in the process of emmetropization, independently of retinal changes. Further investigation is required to elucidate these relationships and to investigate the potential value of therapeutic interventions at the level of the choroid in early ages to halt myopia progression.

Keywords: myopia, subfoveal choroidal thickness, central subfield thickness, axial length, spherical equivalent.

Resumo

Objetivo: Analisar e comparar a espessura da coroide subfoveal (SCT), a espessura da retina no subcampo central (CST) e o comprimento axial (AL) numa população de crianças míopes versus não míopes.

Métodos: Quarenta e quatro olhos foram incluídos neste estudo retrospetivo de vinte e duas crianças com idade compreendida entre 6 e 11 anos (idade média 9,72 ± 1,46 anos). Os pacientes foram classificados com base no equivalente esférico (SE) do erro refrativo como sendo míopes (SE ≤ -0,75 dioptrias (D)) ou não míopes (SE entre +1,00 D e -0,50 D). Excluímos crianças com idade superior ou inferior à faixa etária referida e com astigmatismo superior a 1,00 D.

Todas as crianças foram submetidas a um exame oftalmológico detalhado, incluindo refração não cicloplégica, biometria ótica e tomografia de coerência ótica de domínio espectral (SD-OCT). Vinte olhos eram míopes com equivalente esférico médio -2,43 ± 1,1 D e vinte e quatro olhos emétropes (SE médio 0.00D). A distribuição normal dos resultados foi testada com o teste de Kolmogorov Smirnov; teste t Student independente, teste U de Mann-Whitney e análise de variância de medida repetida (RMANOVA) foram usados para analisar variáveis contínuas. O qui-quadrado de Pearson foi usado para comparação de variáveis categóricas.

Resultados: A espessura subfoveal da coróide foi significativamente mais fina nos míopes (média 248±45 µm) quando comparada à das crianças emétropes (média 321±26 µm) ($p<0,001$). Não houve diferença significativa na espessura retiniana do subcampo central entre os 2 grupos: míope (mediana 217±37 µm) e emétrope (mediana 217±19 µm) ($p=0,944$). O Comprimento Axial foi significativamente maior nas crianças míopes (média 24,47±0,6 mm) do que nas crianças emétropes (média 23,23 ±0,4 mm) ($p<0,001$).

Conclusão: A espessura da coroide, particularmente a SCT, mostrou-se mais fina em crianças míopes quando comparada às crianças emétropes, enquanto não houve diferenças significativas na espessura retiniana do subcampo central entre os dois grupos. Estes resultados sugerem que a coróide desempenha um papel importante no processo de emetropização, independentemente das alterações retinianas. Mais investigações serão necessárias para elucidar estas relações e investigar o potencial de intervenções terapêuticas no nível da coróide em idades precoces para interromper a progressão da miopia.

Palavras-chave: miopia, espessura da coroide subfoveal, espessura do subcampo central, comprimento axial, equivalente esférico.

Abbreviation List

ACD- anterior chamber depth

AL- Axial length

BCVA- Best corrected visual acuity

CR- Cornea curvature radius

CSI- Choroid-sclera interface

CST- Central subfield thickness

CT- Choroidal thickness

CW Chord- Charing-Waring Chord

EDI- Enhanced Depth Imaging

ETDRS- Early Treatment Diabetic Retinopathy Study

IQR- Interquartile Range

LogMAR- Logarithm of the Minimum Angle of Resolution

LT- Lens thickness

OK- Orthokeratology

RLRL- Repeated low-level red-light therapy

RMANOVA- Repeated measures analysis of variance

SCT- Subfoveal choroidal thickness

SD-OCT- Spectral Domain Optical Coherence Tomography

SE- Spherical equivalent

WTW- White-to-white

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Background

Myopia, also known as nearsightedness, is one of the most common refractive errors that is often regarded as a benign disorder as it can easily be corrected through the use of spectacles, contact lenses and refractive surgery.

The refractive status of one´s vision is determined by 3 major components: the corneal power, the lens power, and the axial length. Axial length is defined as the sum of the anterior chamber depth, lens thickness and vitreous chamber depth. Myopia is usually related to the continuous elongation of the vitreous chamber that often ceases at adult age but can also be influenced by a high corneal power that stabilizes around preschool age.[1,2]

The global increase in urbanization, which led to less outdoor activities, increasing daily usage of electronic gadgets along with even more competitive educational pressure in children and young adults,[3–5] have shown an association to the rise of myopia prevalence and incidence over the past decades.[6] It is also estimated that half of the entire global population will be myopic in 2050, in which 10% will be high myopes.[6] These estimates of myopic shift will be greater if accounted the impact from 2020 SARS-COV-2 pandemic that resulted in social distancing, home lockdown, increased use of digital and online learning platforms as well as reduced outdoor activities.[7–10]

Although myopia by itself has limited impact on vision health, the risk of potential vision threatening complications such as glaucoma, retinal detachment, macular degenerative changes and cataracts is significantly higher among myopic population, increasing further with each diopter(D) decrease and therefore the incidence of these complications is particularly relevant among those with high myopia,[11] defined as spherical equivalent equal or lesser than -6.0 D, [12]although it is often associated with axial length equal or greater than 26 mm.[13,14]

Promising methods of halting progression of myopia in myopic children includes the pharmacological use of atropine drops; repeated low-level red light therapy (RLRL) and vision correction methods that are based on decreasing the hyperopic defocus at peripheral retina; mainly through progressive soft contact lenses and orthokeratology (OK) contact lenses, which have shown more effectiveness at myopia control when compared to the use of single-vision spectacles alone.[15–19]

Many studies highlight the importance of the choroid not only for nutrient and oxygen supply to the retina but also for two other essential functions: the adjustment of the retinal position through changes in choroidal thickness and release of growth factors involved in the

modulation of vascularization that would ultimately lead to scleral remodeling and eye growth.[20–24] Simultaneously, there is also controversial data about the progression of choroidal thickness through young age shown by some longitudinal studies.[25–29]

Thus, our current study aims to analyze and compare subfoveal choroidal thickness (SCT), retinal central subfield thickness (CST) and axial length in children's myopic versus non-myopic eyes.

Material and Methods

Settings and Participants

We conducted a retrospective cohort analysis, performed upon the clinical database available from December 2021 to May 2022, from which a total of 22 children (44 eyes) were enrolled and selected at the outpatient clinic of the Ophthalmology department of a Tertiary center (Centro Hospitalar Universitário de Santo António– Porto, Portugal). Prior approval from CHUdSA-ICBAS ethics committee was obtained, and informed consent was provided by legal guardians of all participating children. All participants were treated in accordance with the tenets of the Declaration of Helsinki.

Children with ages between 6 and 11 years old were included. Patients were classified based upon the spherical equivalent (SE) refractive error as being myopic ((SE ≤-0,75 Diopters (D))) or non-myopic (SE between +1,00 D and -0,50D). Patients within other age range and with astigmatism higher than 1,00 D were excluded.

Research Methods

The participants´ standard clinical information such as sex, age, birth history, family history of myopia was obtained through medical appointment and consultation of past medical history.

An ophthalmic examination was carried out in all children which includes best corrected visual acuity (BCVA) using a Snellen chart set at 6m away, converted posteriorly into logMAR score; non-cycloplegic refraction status was obtained using an auto-refractometer (Topcon KR-800PA) and subjective refraction; intraocular pressure was measured using a non-contact tonometer (Topcon CT-800A); fundus examination by slit lamp biomicroscopy; choroidal thickness and retinal thickness values were collected with Spectral-Domain Optical Coherence Tomography (Spectralis by Heidelberg Engineering®) and the axial length with with Zeiss IOL Master 700® optical biometry.

All children were evaluated by the same doctor and technician during the afternoon between 02:00 pm and 04:00 pm to discard any potential cyclic changes of CT during the day and both eyes ´results were collected.[30]

SD-OCT procedure and data collection

All eyes underwent posterior segment Spectral-Domain Optical Coherence Tomography with Enhanced-Depth Imaging OCT (SD EDI OCT), performed with Heidelberg Spectralis HRA+

OCT (Heidelberg Engineering). This machine uses an 815 nm-wavelength light source and has a maximum scanning speed of 85 000 A-scans per second.

The field of the lens was set at 20º, 25 horizontal scans were carried out with a resolution of 1024×496 (Fig.1) and Early Treatment Diabetic Retinopathy Study (ETDRS) grid 1,3,6 mm was then deployed once the tomography panel generated. (Fig.2) This divided the macula into three concentric circles with fovea at the center and created 9 separate regions: the central foveal region (diameter= 1mm), the parafoveal region (diameter = 3 mm), and the perifoveal region (diameter = 6 mm). This division has further generated nine zones: the central foveal zone and the temporal, nasal, inferior, and superior zones of the respective parafoveal and the perifoveal regions.

The custom-built software carried out automatically the segmentation and measurement of retina and its separate layers according to the International Nomenclature for Optical Coherence Tomography Panel.[31] (Fig.3) (Fig.4)

The choroidal thickness was obtained by manual measurement of the distance between the Bruch membrane and the choroid-sclera interface (CSI). Measurements were taken at the central foveal zone, 1.5mm and 3mm of each superior, inferior, temporal, and nasal zone (Fig. 2) by the same experienced retinal specialist. (Fig.5) (Fig.6)

All SD-OCT scans were reviewed for image quality and adequate signal strength.

We also tested the SD-OCT automatic measurement reproducibility by repeating twice in the first 5 patients.

Statistical analysis

Statistical analysis was performed using SPSS software version 27.0 (IBM Corp., Armonk, NY, USA). Both patients´ eyes were used for statistical analysis and spherical equivalent refraction (SE) was used for evaluation of refractive status.

Normal distribution of the sample was examined using Kolmogorov Smirnov test. All respective characteristics are demonstrated as mean± standard deviation for continuous variables with normal distribution, in non-normally distributed variables they would be expressed as median (interquartile range [IQR]). All the categorical data obtained was expressed as number or percentage. Independent Student t-test was carried out for comparison of continuous variables that have a normal distribution between the two groups. Mann-Whitney

U test was performed to compare continuous variables that were not normally distributed. Pearson chi-square test was then used to compare categorical variables.

Repeated measures analysis of variance (RMANOVA) was then used to compare choroidal thickness at different locations.

P-value was set at 0.05 (two-tailed) to confirm statistical significance.

Results

Patient Characteristics

Forty-four eyes from twenty-two children were included and analyzed. The mean age was 9.72 ±1.46 years (range: 6-11 years), with no significant difference between groups. All myopic children had non cycloplegic BCVA of 20/20. The mean SE, based on subjective refraction, was -2.43 ± 1.1 D in the myopic group. (Table 1)

Biometric data

Myopic children had longer axial length (24.47 vs. 23.23 mm, $p<0.001$) and deeper anterior chamber depth (ACD, 3.85 vs. 3.73 mm, $p<0.001$) comparing with control group. On the other hand, white-to-white (WTW) ($p=0.044$), CW chord ($p=0.014$) and lens thickness (LT) ($p=0.001$) were higher in emmetropic children when compared to the myopic group. (Table 2)

Gender subgroup analysis revealed no significant differences in AL and other biometric parameters among the two groups ($p>0.263$).

SD Optical Coherence Tomography findings

From the analysis of SD-OCT data, we found that there was no difference in retinal central subfield thickness (CST) ($p=0.944$) between the myopic group (median value of 217±37 μm) and the control group (median value of 217±19 μm). Concerning to parafoveal retinal thicknesses, myopic children presented slightly higher values than the control group, such as in the superior ($p=0.050$) and temporal parafovea ($p=0.010$) and superior ($p=0.038$) and inferior perifoveal areas ($p=0.040$). (Table 3)

The subfoveal choroidal thickness was significantly thinner in myopic children (mean 248±45 vs. 321±26 μm, $p<0.001$). We also found that the choroidal thickness was generally thinner in myopes in all analyzed macular fields (Superior, inferior, temporal and nasal), except at the 3mm nasal side ($p=0.283$) when compared with the control group. (Table 3)

Subgroup analysis found no significant differences in SCT and CST between different gender ($p=0.606$).

Repeated measures analysis of variance and posterior pairwise comparison of thickness in different choroid locations showed that choroid is thickest at sub foveal, superior, inferior, and temporal side and thinnest in the nasal side in both groups ($p<0.001$). (Fig. 7)

At temporal and nasal regions there is a significant difference in choroidal thickness between 1.5mm and 3mm measurements in both groups ($p<0.001$). (Fig. 7)

Discussion

Our results confirm that CT is significantly thinner in myopic children in all regions when compared to non-myopic children. Previous studies also confirm that the difference is more noticeable at subfoveal location and parafoveal regions.[25–29,32–37] Perifoveal choroidal thickness was the thinnest when compared to parafoveal and subfoveal CT, a finding that may suggest that this thinning process starts from the periphery towards the center.[26] This could be important as a thinner temporal choroid in myopic children may also be used to predict a greater myopic shift.[27] This finding may help to identify children at risk, who may benefit from control axial elongation with potential preventive strategies**.** Previous studies have also shown that choroidal thickness is thinnest at nasal side and thicker at superior and temporal locations, in agreement with our results.[33,34]

The mean SCT obtained in our study (248±45 μm) in the myopic group is comparable with values obtained in published Asian studies that involved children with the same age,[32,36] but thinner than the values obtained from other European studies.[28,33–35] On the other hand, the mean value of SCT in the emmetropic group (321±26 μm), is comparable to the results reported in studies involving caucasian children,[32,36] and thicker than in non-myopic Asian children of the same age.[28,33–35]

Recent cross-sectional studies confirm that myopic children exhibit thinner choroidal thickness when compared to emmetropic children of the same age and sex.[32–35] On the other hand, longitudinal studies regarding retinal thickness have shown its overall stability during the first years of follow-up in myopic and non-myopic children. Jin et al and Xu et al have also demonstrated that while SCT decreased in myopic children in the follow-up, the retinal thickness increased when compared to the baseline.[25,26]

The median retinal CST in our study was 217± 37 μm in myopic children and 217±19 μm in the non-myopic group, which is consistent with the previous studies.[28,33]

There was no significant statistical difference in CST between the two groups, suggesting that choroid changes may precede retinal changes in myopic population. Although there were significant statistical differences in parafoveal superior, temporal and perifoveal superior, inferior retinal thicknesses, showing that myopes possess thicker retina than emmetropes**,** the exact meaning of these findings is not fully understood, and more studies are needed to clarify the significance of these results.

Combining the findings from choroid and retina, these studies suggest that choroidal changes may occur earlier than retina thickness changes in early ages. Interventions avoiding CT thinning may have a role in preventing myopia progression, although there are many other factors to consider.[26,32] Tian et al also suggested that in non-myopic children a thinner temporal retinal thickness at baseline was associated with greater axial elongation over 1 year.[27] This is particularly important as emmetropic children at this age may also develop myopia years after.

In our study the mean axial length of our myopic children was 24.47±0.6 mm which was consistent with other studies including myopic children of the same age.[27,32–34] Our emmetropic group presented a mean axial length value of 23.23±0.4 mm, that, when analyzed against a large European pediatric population database with the same age, was consistent with the 50th percentile values for axial length.[38]

Baseline axial length in children may be different when comparing Caucasian and Asian pediatric populations, when age and sex-adjusted, which may serve as one of the many explanations for the big discrepancies of myopic incidence and prevalence between different ethnicities.[38,39]

Xu et al found a negative linear correlation between axial length and central subfoveal choroidal thickness after multiple regression analysis, although only a small portion of this relationship can be explained by these models, suggesting its complexity. [25]

Our findings appear also to be in line with those reported by Rozema J et al and Jin et al, suggesting that axial elongation can be observed early before myopia onset, [26,40] and this could also partially explain the reason behind the largest yearly incidence and prevalence of myopia in pediatric population in East Asia.

We also found that lens thickness and WTW to be significantly smaller in myopes and the anterior chamber deeper within the same group when compared with the emmetropic children. These findings are also consistent with other studies.[33,41] Xu et al also concluded that WTW decreased with the severity of the myopia while ACD increased with the degree of myopia.[41] The exact relationship between these biometric parameters and myopia is still not fully understood, but it is presumed to be a consequence of axial length elongation.

Some studies suggested that the ratio AL/CR (corneal curvature radius) may serve as a good predictor of children at risk for developing myopia before its onset, as children with greater myopic shift had a higher AL/CR ratio when compared to those who remained emmetropic.[26,39] It would be interesting to collect this parameter in future re-evaluations.

Our study had important limitations to consider. At first, we didn't possess the data regarding height, mass and puberty state which could have significantly influenced the interpretation of the results.[42,43] Secondly, our sample size was limited and may have reduced the statistical power of our analyses and conclusions, although we included a considerable control group size in this study. Thirdly we did not perform cycloplegic refraction measurements, as it may alter the refraction values and subfoveal choroidal thickness results in children.[44–46] Nevertheless, we believe the impact of cycloplegia in determining subjective myopic refractive error in the age group included in this study is limited.

Finally, we didn't test the interobserver repeatability in choroidal manual measurement, although all the analysis and measurements were done by the same experienced team.

We also did not include the data about the different layers of the retina such as the ganglion cell layer and retinal nerve fiber layer, since one study suggested it to be thinner in myopes,[35] and Xu et al found that ganglion cell layer and outer nuclear later thickness increased in the follow-up of myopic children,[41] which would be interesting to find out in future investigation.

To date this is the first study in Portugal to attempt collection of data and setting up a database concerning different eye parameters in myopic children. It is planned in the future to re-evaluate the same cohort, repeating similar measurements with the same techniques and equipment to create a longitudinal database and correlate with the findings from other longitudinal studies available worldwide. This cohort is expected to grow in number of participants if considered the data from other Portuguese tertiary care centers in the future and therefore it might serve as a better representative sample of Portuguese, European and Caucasian children.

Conclusion

Choroidal thickness, particularly SCT, is thinner at all regions in myopic children when compared to emmetropic children, while there were no significant changes in retinal CST between the two groups, suggesting that choroid might play an early and important role in the process of emmetropization, independently of retinal changes. From early ages, thinner choroids seem to be associated with longer axial lengths, characteristic of myopia. Further investigation is required to elucidate these relationships and to investigate the potential value of therapeutic interventions at the level of the choroid in early ages to halt myopia progression.

Tables

Table 1 – Demographic and refractive data

	Emmetropic	Myopia	Total	*p* value
Demographic data				
Eyes, n (%)	24 (54.5)	20 (45.5)	44 (100)	
Patients, n (%)	12 (54.5)	10 (45.5)	22 (100)	
Age (mean ± SD)	9.78(1.56)	9.65 (1.36)	9.72 (1.46)	0.772[1]
Male, n (%)	8 (67)	5 (50)	13 (59)	0.263[2]
Refractive data				
BCVA (Converted logMAR)	0	0	0	
Sphere (D)	0	-2.24 (1.1)	-1.01 (1.3)	**<0.001[1]**
Cylinder (D)	0	-0.38 (0.6)	-0.17 (0.5)	**0.015[1]**
SE (D)	0	-2.43 (1.1)	-1.10 (1.4)	**<0.001[1]**

1-Independent Samples T-test
2-Pearson Chi- Square Test

Table 2 – Biometric data

	Emmetropic	Myopia	Total	p-value
Biometric data				
AL (mm)	23.23 (0.4)	24.47 (0.6)	23.79 (0.8)	**<0.001[1]**
ACD (mm)	3.73 (0.1)	3.85 (0.2)	3.79 (0.2)	**0.007[1]**
LT (mm)	3.50 (0.1)	3.38 (0.1)	3.45 (0.1)	**0.001[1]**
WTW (mm)	12.5 (0.3)	12.3 (0.2)	12.4 (0.3)	**0.044[1]**
K1 (D)	42.44 (1.1)	42.84 (1.1)	42.6 (1.1)	0.240[1]
K2 (D)	43.18 (1.0)	43.68 (1.1)	43.4 (1.1)	0.118[1]
Delta K (D)	-0.71 (0.3)	-0.84 (0.5)	-0.8 (0.4)	0.132[1]
TK1 (D)	42.57 (1.1)	42.94 (1.1)	42.6 (1.1)	0.279[1]
TK2 (D)	43.17 (1.1)	43.70 (1.1)	43.4 (1.1)	0.113[1]
Delta TK (D)	-0.60 (0.2)	-0.75 (0.5)	-0.7 (0.4)	0.223[1]
Pupil (mm)	6.5 (0.9)	6.1 (1.1)	6.3 (1.0)	0.437[1]
Ix (mm)	0.02 (0.5)	-0.03 (0.4)	-0.005 (0.4)	0.724[1]
Iy (mm)	0.02 (0.1)	0.09 (0.2)	0.05 (0.1)	0.123[1]
CW Chord (mm)	0.35 (0.2)	0.25 (0.1)	0.3 (0.1)	**0.014[1]**
CCT (µm)	559 (33)	541 (32)	550 (33)	0.076[1]

1 – Independent samples t-test

AL- Axial Length
ACD- Anterior Chamber Depth
LT- lens thickness
WTW- white-to-white
K1- flat keratometry
K2- steep keratometry.
Delta K- difference in K
TK1- Flat Total keratometry
TK2- Steep Total keratometry
Delta TK – difference in TK
Pupil- Pupil diameter
Lx- X- axis of corneal apex towards iris center shift
Ly- Y-axis of corneal apex towards iris center shift
CW Chord- Chang-Waring Chord/ Angle Kappa
CCT- Central Corneal Thickness

Table 3 – SD-OCT data

	Emmetropic	Myopia	Total	*p* value
Retina (µm) Median (IQR)				
CST	217 (19)	217 (37)	218 (10)	0.944[1]
Parafoveal				
Superior	340 (51)	346 (61)	339 (21)	**0.050[1]**
Inferior	341 (47)	342 (56)	336 (20)	0.077[1]
Temporal	323 (43)	332 (59)	325 (20)	**0.010[1]**
Nasal	345 (60)	344 (65)	340 (23)	0.157[1]
Perifoveal				
Superior	292 (49)	307 (48)	297 (17)	**0.038[1]**
Inferior	285 (42)	292 (54)	285 (16)	**0.040[1]**
Temporal	282 (43)	289 (50)	282 (16)	0.089[1]
Nasal	318 (59)	319 (59)	315 (20)	0.267[1]
Retina volume	8.59 (1.2)	8.74 (1.4)	8.56 (0.5)	0.081[1]
Choroid (µm) Mean ± SD				
Subfoveal	321 (26)	248 (45)	288 (51)	**<0.001[2]**
Superior 1.5 mm	335 (42)	258 (49)	300 (59)	**<0.001[2]**
Superior 3.0 mm	309 (35)	276 (60)	294 (50)	**0.036[2]**
Inferior 1.5 mm	311 (41)	242 (46)	279 (55)	**<0.001[2]**
Inferior 3.0 mm	308 (53)	263 (60)	287 (60)	**0.012[2]**
Temporal 1.5 mm	340 (35)	246 (33)	297 (58)	**<0.001[2]**
Temporal 3 mm	305 (51)	197 (34)	256 (70)	**<0.001[2]**
Nasal 1.5 mm	253 (36)	203 (41)	230 (46)	**<0.001[2]**
Nasal 3 mm	142 (33)	132 (29)	137 (31)	0.283[2]

1 – Mann-Whitney U test
2- Independent Samples T-test

Figures

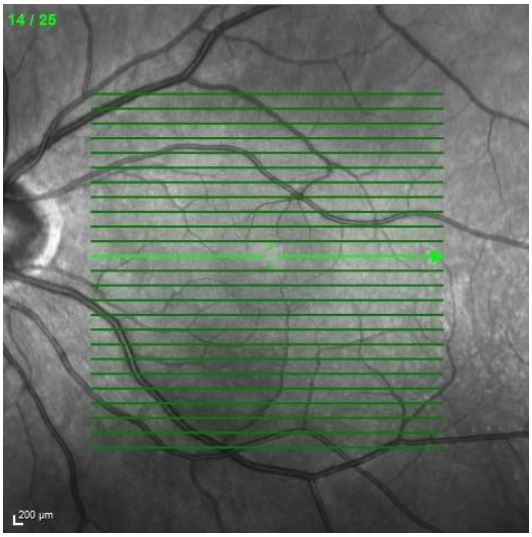

Figure 1. OCT Horizontal scans.

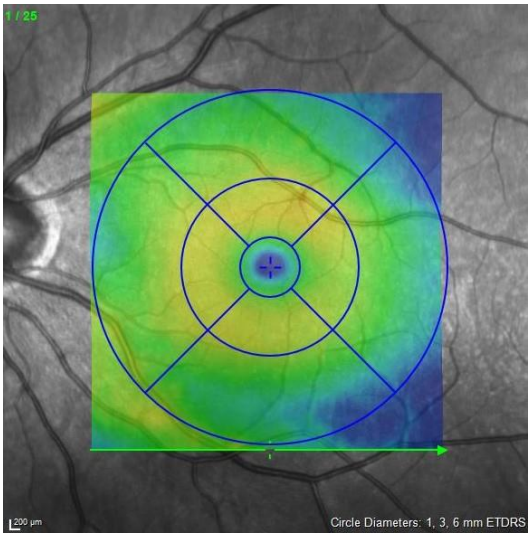

Figure 2. ETDRS Grid employed.

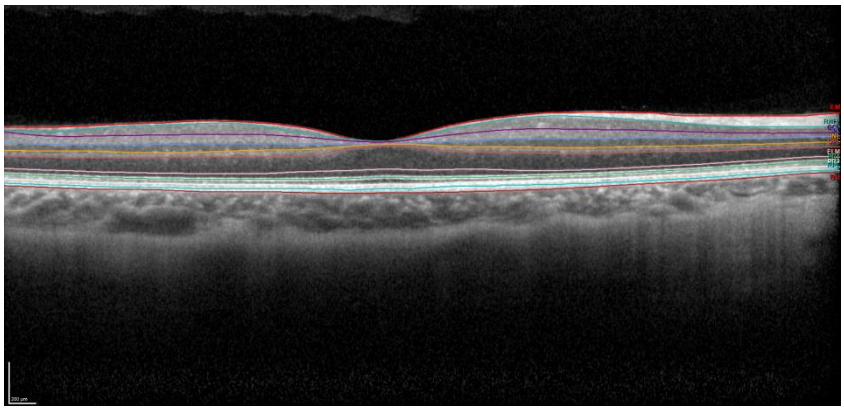

Figure 3. Automatic segmentation of retinal layers.

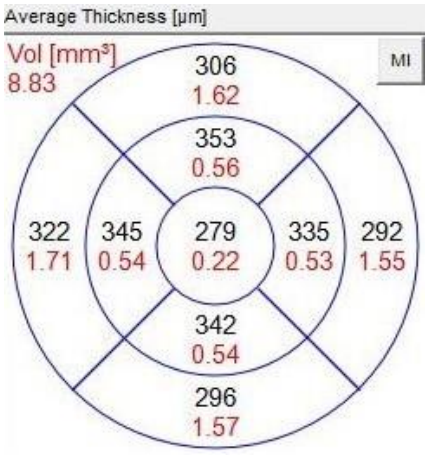

Figure 4. Average values of retinal thickness at different regions obtained by software.

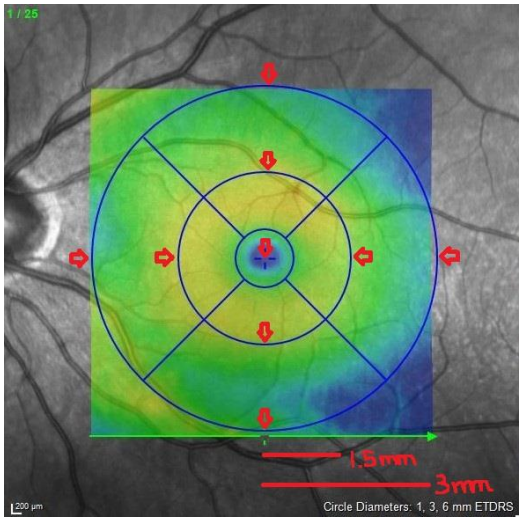

Figure 5. Manual measurement locations.

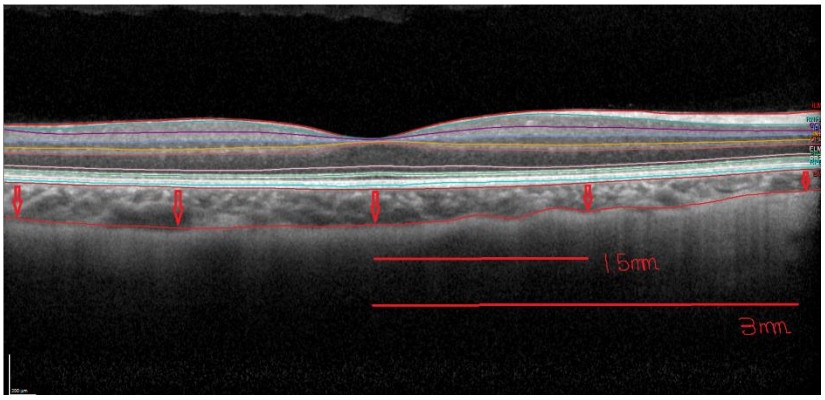

Figure 6. Manual Segmentation and measurement of choroidal thickness at respective locations.

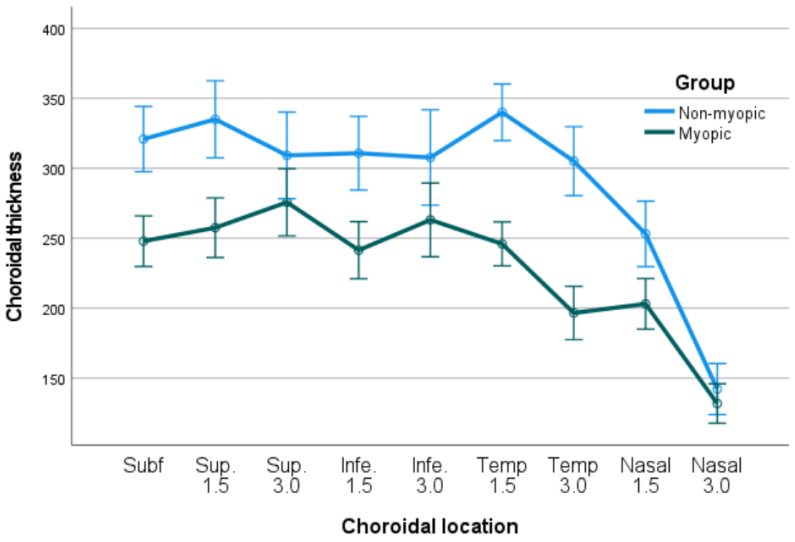

Figure 7. Choroidal variations in the two groups, error bars with 95% confidence interval.

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