Peripapillary Choroidal Thickness in Young Asians With High Myopia

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Purpose. To describe the topography and predictors of peripapillary choroidal thickness (PPCT) in highly myopic eyes of young, healthy, Asian subjects.

Methods. A total of 870 young male subjects aged 21.63 ± 1.15 years were recruited from the Singapore military. Choroidal imaging was performed using enhanced depth imaging (EDI) spectral-domain optical coherence tomography (SD-OCT). Peripapillary choroidal thickness was manually measured at eight locations around the optic disc.

Results. We analyzed 448 subjects with high myopia (defined as spherical equivalent [SE] worse than −6.0 diopters [D]) and 116 with emmetropia (SE > −0.5 and < 0.5 D). The mean SE was −8.52 ± 1.20 D for the high-myopic group, and 0.11 ± 0.24 D for the emmetropic group. The mean peripapillary choroid was significantly thinner (142.62 ± 43.84 μm) in high myopes compared with emmetropes (181.90 ± 46.43 μm, $P < 0.001$). Likewise, PPCT showed further decrease with increase in degree of myopic refractive error. Distribution of PPCT showed a markedly different pattern in high-myopic eyes (thickest superiorly) and emmetropic eyes (thickest temporally). However, peripapillary choroid in both the groups was thinnest at the inferior location. Among the ocular factors studied, axial length, IOP, presence of posterior staphyloma, and chorioretinal atrophy were the factors significantly associated with PPCT.

Conclusions. Highly myopic eyes have significantly thinner peripapillary choroid and showed different distribution of thickness, compared with emmetropes. Axial length, IOP, and presence of posterior staphyloma and chorioretinal atrophy significantly influence PPCT and should be taken into consideration during clinical interpretation of PPCT measurement.

Keywords: myopia, peripapillary choroidal thickness, spectral-domain optical coherence tomography

The choroid contributes blood supply not only to the outer retina[1] including retinal pigmented epithelium (RPE) and photoreceptors, but also to the prelaminar portion of the optic nerve.[2] Given the role of the choroidal vasculature in the blood supply of the anterior optic nerve head, a variety of ocular pathologies including glaucoma[3,4] and high myopia[5] occur in the peripapillary choroidal region. High myopia itself is also associated with a high prevalence of retinal complications such as posterior staphyloma,[6,7] lacquer cracks,[8] chorioretinal atrophy as well as optic disc changes, such as oval configuration, larger area of peripapillary atrophy, and disc tilt and rotation,[9] which may potentially affect the thickness and distribution profile of peripapillary choroid. Quantitative analysis of peripapillary choroidal thickness (PPCT) may help elucidate the mechanisms through which the peripapillary choroid affects these diseases. With the advancement in imaging technology, optical coherence tomography–based enhanced depth imaging (EDI-OCT)[10] provides an easy and noninvasive way to measure PPCT.

Several studies have previously compared choroidal thickness in the macula area between myopes versus healthy eyes.[11–15] However, none of the studies have explored the distribution of choroidal thickness around the optic disc in high myopes. Although a few studies have also reported on the characteristics of PPCT in healthy eyes,[16–19] most were performed retrospectively in relatively small clinic-based samples, and thus generalization of findings may be limited. The aim of our study was to quantify and compare the pattern of distribution of PPCT based on the degree of myopia and to determine the ocular determinants of PPCT measured by EDI

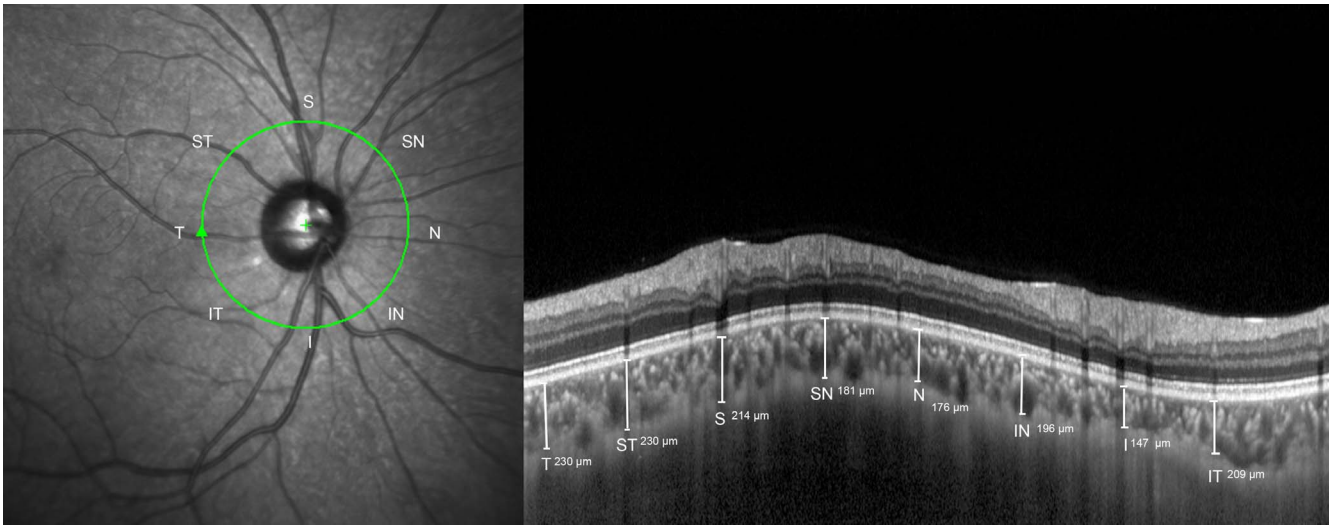

FIGURE 1. Enhanced-depth imaging OCT image demonstrating peripapillary region scanned using a 360°, 3.5-mm diameter circle centered on the optic disc. The peripapillary choroidal thickness was measured as the perpendicular distance between Bruch's membrane and the choroid–scleral interface at the following locations: T, temporal; ST, superotemporal; S, superior; SN, superonasal; N, nasal; IN, inferonasal; I, inferior; IT, inferotemporal.

spectral-domain (SD)-OCT in an Asian sample. We used a case-control study approach of young, highly myopic, and emmetropic healthy male adults selected from a large population from the Singapore military. Accurate and reliable measurements of PPCT and knowledge of its normal distribution is of clinical importance in the diagnosis and management of diseases where choroid is implicated in the pathophysiology.

MATERIALS AND METHODS

Study Population and Design

A total of 28,908 male adults were screened for myopia (mean age ± SD: 19.8 ± 1.2 years; range, 17–29 years) from 2009 to 2010 as part of a mandatory medical eye review for employment purposes. Measured using noncycloplegic autorefraction (Huvitz MRK-3100P; Huvitz Co., Ltd., Geumjeong-dong, Gunpo-si Gyeonggi-do, South Korea), 2584 persons were identified to have myopia with spherical equivalent (SE) of –6.0 diopters (D) or worse. Of these 2584 persons, 719 were selected on the basis of a refractive error–stratified random sampling strategy and underwent a further comprehensive ophthalmologic examination at Singapore Eye Research Institute from December 2011 to June 2012. Their SE was further confirmed by subjective refraction, and those with SE less than –6.0 D ($n = 96$) were excluded, leaving 623 subjects with high myopia (251 with SE between –6.0 D and –8.0 D; 207 with SE between –8.0 D and –10.0 D; 165 with SE –10.0 D or worse). In addition, 151 emmetropes who had SE between ±0.5 D in both eyes measured using autorefraction were recruited as controls and went through a similar ophthalmologic examination. Subjects were further excluded if they did not give consent to take part in this medical review, had any previous ocular trauma or surgery, and those with other clinically significant ocular comorbidity.

Written informed consent were taken from the subjects and their parents/guardians (if they were 21 years old and younger). Ethics approval was obtained from the institutional review board of Singapore Eye Research Institute, Singapore. The study was conducted in accordance with the tenets of the World Medical Association's Declaration of Helsinki.

Ophthalmic Examination and Measurements

Objective refraction was measured using Canon Autorefractor RK-F1 (Tokyo, Japan). Spherical equivalent was calculated as the sum of the spherical power and one-half of the cylinder power. Best-corrected visual acuity (BCVA), in which refraction was corrected, was measured monocularly using a logarithm of the minimum angle of resolution (logMAR) chart (Lighthouse International, New York, NY, USA) at a distance of 4 m. Biometry measurements (i.e., axial length [AL], anterior chamber depth [ACD], and keratometry readings) were obtained from the noncontact Zeiss IOL Master (V3.01; Carl Zeiss Meditec AG, Jena, Germany). Intraocular pressure was measured using Nidek noncontact tonometry (Auto Non-Contact Tonometer, NT-3000; Nidek, Gamagori, Aichi, Japan) and if IOP was found to be 21 mm Hg or more, Goldmann applanation tonometry (Haag-Streit, Bern, Switzerland) was performed by study ophthalmologists.

Subjects underwent slit-lamp examination. Binocular indirect ophthalmoscopy was performed approximately 30 minutes after topical instillation of three drops of tropicamide and 2.5% phenylephrine, given 5 minutes apart. Dilated fundus examination was carried out by the study ophthalmologist. The presence and type of peripheral retinal degenerations and vitreous degenerations were systematically documented. Fundus photography was performed using nonmydriatic retinal camera (Canon CR-DGi with a 10D/20D/40D SLR back; Canon, Tokyo, Japan).

OCT Imaging

The peripapillary choroidal parameters were determined using SD-OCT (Spectralis, Wavelength: 870 nm; Heidelberg Engineering, Heidelberg, Germany). Peripapillary choroid was imaged with EDI modality after pupil dilation. Enhanced-depth imaging is a method that improves resolution of choroidal detail by automatically setting the choroid closer to the zero-delay line, and thus provides better visualization of the choroid scleral interface than in standard retinal SD-OCT images. The peripapillary region was scanned using a 360°, 3.5-mm diameter circle centered on the optic disc (Fig. 1), each comprising 100 averaged scans (using the proprietary automatic averaging and eye tracking features of the SD-OCT

Table 1. Clinical Characteristics of the Study Subjects

	Myopes, $n = 448$	Emmetropes, $n = 116$	P Value*
Age, y	21.63 (1.15)	22.03 (0.96)	<0.001
AL, mm	27.23 (1.07)	23.70 (0.61)	<0.001
ACD, mm	3.74 (0.25)	3.46 (0.27)	<0.001
Corneal curvature, mm	7.76 (0.25)	7.81 (0.41)	0.123
SE, D	−8.52 (1.80)	0.11 (0.24)	<0.001
BCVA, logMAR	0.01 (0.07)	−0.09 (0.06)	<0.001
IOP, mm Hg	16.11 (2.95)	15.22 (2.64)	0.003
RNFL thickness, μm	87.21 (8.94)	103.76 (9.99)	<0.001

Data presented are means (SD).
* Based on independent sample *t*-test.

Table 2. Intragrader Reliability of Peripapillary Choroidal Thickness Measurements in Myopic and Emmetropic Group at Different Locations

Locations of Measurement	Myopes ICC (95% CI)	Emmetropes ICC (95% CI)
PPCT		
Temporal, 360°	0.97 (0.92–0.98)	0.96 (0.90–0.98)
Superotemporal, 45°	0.97 (0.94–0.99)	0.98 (0.95–0.99)
Superior, 90°	0.98 (0.96–0.99)	0.96 (0.90–0.98)
Superionasal, 135°	0.98 (0.96–0.99)	0.97 (0.92–0.98)
Nasal, 180°	0.97 (0.93–0.99)	0.96 (0.90–0.98)
Inferonasal, 225°	0.96 (0.92–0.98)	0.96 (0.91–0.98)
Inferior, 270°	0.96 (0.91–0.98)	0.95 (0.88–0.98)
Inferotemporal, 315°	0.96 (0.90–0.98)	0.96 (0.90–0.98)

device). Following Spectralis user manual guidelines, subjects' keratometry readings and refraction were entered into the Spectralis' software before the choroid was imaged to estimate optical magnification, thus allowing for more accurate comparisons across individuals. However, Spectralis OCT does not allow AL to be input, our methods may still have residual errors (2%–7%)[20] due to ocular magnification from methods that additionally uses AL. Only the right eye of each study participant was included for analysis.

Measurement of Peripapillary Choroidal Thickness

The PPCT was measured manually using the Heidelberg Eye Explorer software (version 1.5.12.0; Heidelberg Engineering) as the perpendicular distance between the outer portion of the hyperreflective line corresponding to the RPE (automatically detected by the instrument) to the hyporeflective line or margin corresponding to the sclerochoroidal interface (manually drawn by an experienced grader, who was masked to subject characteristics and clinical diagnosis) at the following locations around the optic disc: temporal, superotemporal, superior, superonasal, nasal, inferonasal, inferior, and inferotemporal. In addition, the intraobserver reliability of PPCT measurements was evaluated in both the myopic and emmetropic group. Forty randomly selected Spectralis images (20 from each group) were assessed again by the same grader after an interval of 1 week.

Statistical Analysis

Subjects were excluded from analysis if they had any history of anterior ocular diseases, previous ocular trauma, evidence of macular or vitreoretinal diseases or any form of refractive surgery done in their eyes. However, conditions such as, peripapillary atrophy, lacquer crack, posterior staphyloma, chorioretinal atrophy, or tilted discs were not excluded, as they are commonly seen in high-myopic eyes. Statistical analysis was performed using SPSS version 17.0 (SPSS, Inc., Chicago, IL, USA) and MedCalc version 12.3 (Medcalc Software, Ostend, Belgium). The intrasession repeatability of the PPCT was measured by the absolute agreement model of the intraclass correlation coefficient (ICC).[21]

The demographics and ocular parameters between myopic and control eyes were compared using independent *t*-tests. For the purpose of analyses, myopic eyes were divided into three groups based on SE: less than –6.0 to –8.0 D, less than –8.0 to –10.0 D, and worse than –10.0 D. Subgroup analysis of choroidal thickness across different locations in eyes with varying degree of myopia was performed. Repeated measures ANOVA with Bonferroni posttest was used to compare mean thicknesses at various locations within each group. Univariate and multiple linear regression analyses were performed to determine the association of ocular factors (independent variables) with PPCT measurements (dependent variables). For multiple linear regression, age, and factors, which showed significant association in univariate analysis ($P < 0.05$) were included.

Results

Of the 623 eligible high myopes (SE ≤ –6.0 D), we further excluded 175 subjects because their choroidal images were not successfully attained due to unstable fixation ($n = 62$), the available images were not of optimal quality (a quality index of < 25 dB as suggested by the manufacturer for the image quality assurance, $n = 39$), those where the choroid–scleral interface was not clearly delineated ($n = 21$) to perform accurate measurements, subjects whose peripapillary atrophy involved the OCT scanning ring ($n = 30$), or they did not meet the inclusion criteria ($n = 23$), leaving 448 high myopes with complete data on PPCT for analysis. Of the 151 emmetropes recruited, 35 were found to have SE greater than ± 0.5 D on subjective refraction and were excluded, leaving 116 emmetropes for analysis.

The mean age of included myopic and emmetropic subjects was 21.63 ± 1.15 years and 22.03 ± 0.96 years ($P < 0.001$), respectively. The mean SE was –8.52 ± 1.80 D (range, –6 to –18.25 D) for myopic group, and 0.11 ± 0.24 D for emmetropic group. Among the myopic group, nearly all our subjects (97.3%) had peripapillary atrophy, 41.3% had posterior staphyloma, 6.3% had chorioretinal atrophy, 0.4% had lacquer cracks, and 22.5% had tilted disc. The demographics and ocular characteristics of the study population are shown in Table 1. In terms of reliability of PPCT measurements, the intraobserver reliability for myopic (ICC: 0.96–0.98) and emmetropic (ICC: 0.95–0.98) group was excellent for all locations of PPCT (Table 2).

Peripapillary choroidal thickness varied significantly across the myopic subgroups and the emmetropic group at all the locations (P for trend < 0.001 for all locations, Table 3). Peripapillary choroidal thickness was significantly thinner in the more myopic eyes over a range of eccentricities and their pattern of distribution was different from emmetropes (Fig. 2). Across the three myopic subgroups, peripapillary choroid was thickest (163.41 ± 50.43 μm) at the superior location, whereas in emmetropes it was thickest (207 ± 58.01 μm) at the temporal location. Peripapillary choroid was thinnest in both myopes (109.98 ± 37.30 μm) and control eyes (137.90 ± 44.53 μm) at the inferior location.

In the univariate analysis, SE, AL, corneal curvature, IOP, average retinal nerve fiber layer (RNFL) thickness, and

Table 3. Distribution of Mean Peripapillary Choroidal Thickness at Different Locations Across the Three Myopic and Control Groups

Locations	Emmetropes, $n = 116$	High Myopia: All, $n = 448$	High Myopia: SE < -6 to -8 D, $n = 211$	High Myopia: SE < -8 to -10 D, $n = 143$	High Myopia: SE < -10 D, $n = 94$	*P* for Trend*
Temporal, 360°	207.00 (58.01)	138.47 (58.57)	151.30 (62.21)	132.45 (51.00)	118.85 (54.41)	<0.001
Superotemporal, 45°	201.89 (53.13)	150.32 (54.10)	160.10 (57.14)	144.51 (49.02)	137.23 (50.82)	<0.001
Superior, 90°	188.18 (50.17)	163.41 (50.43)	170.60 (52.08)	160.88 (47.30)	151.14 (49.03)	<0.001
Superionasal, 135°	189.15 (52.85)	162.21 (50.50)	169.58 (52.26)	159.19 (47.63)	150.24 (48.45)	<0.001
Nasal, 180°	189.24 (53.17)	161.97 (51.82)	170.66 (55.30)	157.36 (47.22)	149.51 (47.30)	<0.001
Inferonasal, 225°	168.68 (50.38)	137.82 (46.16)	146.83 (50.15)	132.62 (41.11)	125.53 (40.04)	<0.001
Inferior, 270°	137.90 (44.53)	109.98 (37.30)	117.01 (39.41)	106.91 (33.54)	98.88 (34.80)	<0.001
Inferotemporal, 315°	173.17 (52.10)	116.81 (49.12)	128.19 (54.12)	110.73 (41.25)	100.52 (42.05)	<0.001
Average	181.90 (46.43)	142.62 (43.84)	151.78 (46.79)	138.08 (38.53)	128.99 (40.20)	<0.001
		$P < 0.001$†	$P < 0.001$†	$P < 0.001$†	$P < 0.001$†	

Data presented are mean (SD) in micrometers.

* Peripapillary choroidal thickness varied significantly across the myopic subgroups and the emmetropic group at all the locations (*P* for trend < 0.001 for all locations).

† Repeated measures ANOVA, comparing the distribution of peripapillary choroidal thickness at various locations within each group.

presence of posterior staphyloma and chorioretinal atrophy were significantly associated with PPCT (all $P < 0.05$, Table 4). For each millimeter increase in AL and corneal curvature, PPCT on average decreased by 13.02 ($P < 0.001$) and 36.72 μm ($P < 0.001$), respectively. A decrease in mean PPCT by 5.39 μm was observed for each myopic diopter increase ($P < 0.001$). Each millimeter of mercury increase in IOP increased the PPCT by 1.40 μm, whereas for each micrometer increase in average

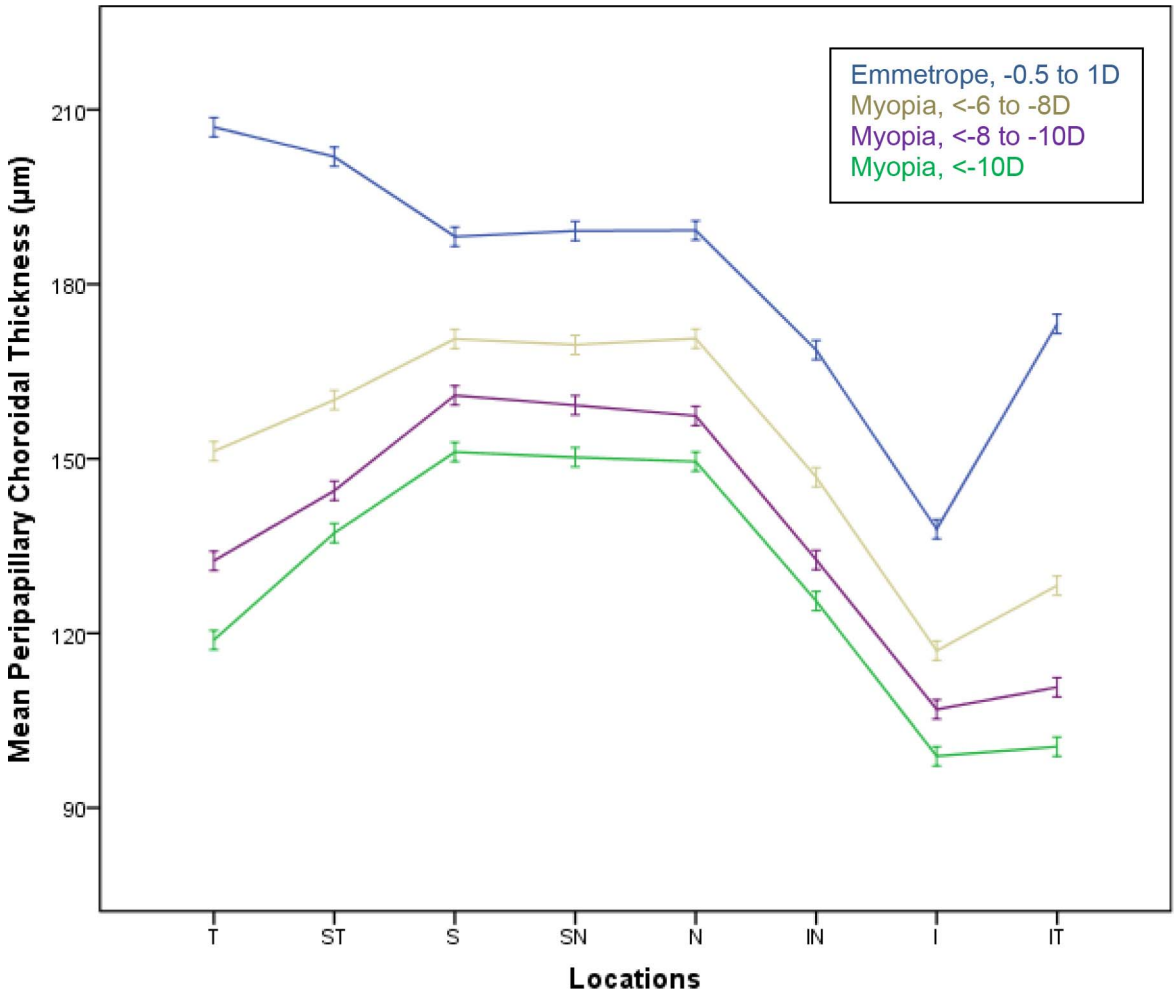

Figure 2. Graph showing the distribution of mean peripapillary choroidal thickness (μm) in high-myopic and emmetropic groups at different locations around the optic disc. The *x*-axis represents the locations of the measurements of peripapillary choroidal thickness around the optic disc. *Error bars* indicate standard error.

Table 4. Association of Ocular Factors With Average Peripapillary Choroidal Thickness in All Myopes ($n = 448$)

	Univariate Analysis			Multivariate Analysis		
	Unstandardized β Coefficient	Standardized β Coefficient	*P* Value	Unstandardized β Coefficient	Standardized β Coefficient	*P* Value
Ocular factors						
Age, y	−0.412	−0.011	0.818	-	-	-
SE, D	5.396	0.222	<0.001	-	-	-
AL, mm	−13.029	−0.319	<0.001	−7.090	−0.175	**0.001**
Corneal curvature, mm	−36.720	−0.216	<0.001	−4.456	−0.026	0.602
ACD, mm	−3.989	−0.023	0.631	-	-	-
IOP, mm Hg	1.407	0.095	0.045	1.628	0.111	**0.006**
Average RNFL thickness, μm	0.745	0.152	0.001	0.287	0.059	0.156
Posterior staphyloma	−15.296	−0.519	<0.001	−12.160	−0.433	**<0.001**
Chorioretinal atrophy	−14.768	−0.247	<0.001	−0.533	−0.089	**0.032**
Tilted disc	−2.814	−0.081	0.088	-	-	-

For multivariate analysis after adjusting for age there was no change in the result. Bold values indicate statistical significance.

RNFL thickness, PPCT increased by 0.74 μm. Presence of posterior staphyloma and chorioretinal atrophy decreased the PPCT by 15.29 and 14.76 μm, respectively (both $P < 0.001$). The results remained similar after adjusting for age (data not shown).

Because of collinearity between AL and SE (correlation coefficient = –0.574), only AL was selected and retained in the multivariate analysis as it had a greater explanatory power on PPCT change than did SE (standardized β, –0.319 vs. 0.222). There was no collinearity between posterior staphyloma and chorioretinal atrophy as variance inflation factor (VIF) was close to 1. In the multiple linear regression analysis, AL ($P = 0.001$), IOP ($P = 0.006$), presence of posterior staphyloma ($P < 0.001$), and chorioretinal atrophy ($P = 0.032$), remained significantly associated with PPCT, whereas the association with corneal curvature ($P = 0.062$) and RNFL thickness was abolished ($P = 0.156$). The results remained similar after adjusting for age. However, on performing a linear regression analysis between IOP and average PPCT in the emmetropic group we found no significant association ($P = 0.964$; regression coefficient = –0.075; 95% confidence interval [CI], –3.334 to 3.183).

Discussion

To our knowledge, this is the first study to measure PPCT directly with EDI SD-OCT in a large group of young, highly myopic Asian subjects. Peripapillary choroid in myopic group was significantly thinner than emmetropic control group at any locations. We demonstrated further decrease in PPCT with increase in degree of myopic refractive error. Peripapillary choroidal thickness distribution follows a different profile in high myopia (thickest superiorly), compared with emmetropia (thickest temporally). However in both the groups peripapillary choroid was thinnest at inferior location. Among the range of ocular factors studied, AL, IOP, and presence of posterior staphyloma and chorioretinal atrophy were the significant factors associated with PPCT.

None of previous studies so far have explored the profile of peripapillary choroid in high myopia and only a limited number of studies have reported the distribution of peripapillary choroid in emmetropic eyes. The mean PPCT in emmetropes was 181.90 ± 46.43 μm, which is in concurrence with former studies showing a mean thickness of 165.03[18] to 191.62[19] μm (Table 5).

In terms of distribution of PPCT, in both myopic and emmetropic eyes, peripapillary choroid was thinnest inferiorly. Studies done so far have consistently shown inferior region to be the thinnest among other regions of the posterior pole.[16–19] As optic fissure is located in the inferior aspect of the optic cup and is the last part of the globe to close,[22] this regional difference in ocular development may contribute to the thinner choroid found in inferior region. Thinner choroid would lead to decreased blood flow in choriocapillaris, which nourishes the prelaminar portion of the optic disk, making it more susceptible to hypoxia or to elevated IOP. This is supported by a very common observation that glaucoma typically affects the inferior optic disc region first.[16,23] The possible role of thinner choroid in glaucoma development is further supported by the findings of Usui et al.[24] and Hirooka et al.[23] who reported significant choroidal thinning in myopic normal-tension glaucoma–damage eyes as compared with myopic controls. Likewise, a substantial reduction in PPCT in patients with glaucoma who have sclerotic optic disc was demonstrated by Robert et al.[4] Tanabe et al.[16] showed thinner choroid in the inferior region of optic disks of healthy eyes. While some investigations[25–27] have reported finding that the PPCT did not seem to differ between healthy and glaucoma patients.

Table 5. Summary of Peripapillary Choroidal Thickness and Other Variables in Various Studies in Healthy Eyes

Study	No. of Eyes	Mean Age, y	AL, mm	SE, D	OCT Machine	EDI (Yes/No)	Mean PPCT,* μm
Current study (myopes)	448	21.63 (1.15)	27.23 (1.07)	−8.52 (1.80)	Spectralis SD-OCT	Yes	142.62 (43.84)
Current study (emmetropes)	116	22.03 (0.96)	23.70 (0.61)	0.11 (0.24)	Spectralis SD-OCT	Yes	181.90 (46.43)
Huang et al.[13]	76	56.95 (12.99)	23.20	0.31 (1.12)	Spectralis SD-OCT	Yes	165.03 (40.37)
Oh et al.[14]	40	41.2 (20.6)	-	−0.4 (1.1)	Topcon 3D-OCT	No	191.2 (62)
Tanabe et al.[11]	28	54.1 (20.0)	-	−3.6 (4.1)	Spectralis SD-OCT	Yes	-
Ho et al.[12]	36	48 (16)	-	-	Cirrus SD-OCT	No	-

* Data presented are means (SD).

We found peripapillary choroid in highly myopic eyes was thickest superiorly, whereas in emmetropic eyes was thickest temporally. This variation in the refractive error differences in choroidal thickness profile could be attributed to the presence of posterior staphyloma in highly myopic eyes. Although staphylomas may have various morphologic features, the most common types involve the macular and optic nerve regions.[28] Similar to our observation in emmetropes, Oh et al.[19] also reported peripapillary choroid to be thickest temporally. However, the observed pattern of PPCT distribution in emmetropes in our study differs from most of the previous studies in healthy eyes, which reported choroid to be thickest superiorly.[4,16–18,23,26] Although, the magnitude of the difference in thickness of the thickest point is not clinically significant (range, 15–20 μm). The differences in PPCT profile in our study compared with other studies could be because of the differences in age of our study participants. Our study participants are twice as young, mean age 22 years compared with other studies.[4,16–18,23,26] Thus, the exact reason for the variations in topographic profile of PPCT is not clear and further studies on a wide range of age group are needed.

Peripapillary choroidal thickness was significantly thinner in eyes with longer AL. The possible reason might be the anatomic differences in eyes of different refractive status with more stretched and therefore thinner peripapillary choroid in longer eyes. Therefore, AL deserves consideration in a normative database of PPCT measurement and should be taken into account while interpreting the results.

Interestingly, we found a positive association between PPCT and IOP in high myopes. Our results are in concordance with previous studies,[29] which using the pressure–volume relationship of the eye,[30] estimated that to produce an IOP increase of 5 mm Hg from the average IOP of 15 mm Hg, the choroid would need to expand uniformly by approximately 10 μm. Our subjects had a mean choroidal thickness increase of 2.38 μm for every millimeter of mercury increase in IOP supporting the conclusion that the IOP increase resulted from choroidal thickness increase.

In addition, we found that presence of posterior staphyloma was significantly associated with choroidal thinning in high myopes. Similar results were observed in the previous studies, which reported posterior staphyloma formation as a key factor in choroidal thinning in highly myopic eyes.[5,31] This association is probably because in myopic eyes with posterior staphyloma, choroidal circulation is altered with marked attenuation and reduction in number of large choroidal vessels.[32] In addition, there is a shift in the entry site of the posterior ciliary arteries toward the staphyloma's border leading to scarce choroidal arterial network in the area occupied by staphyloma.[33] Thus, all these changes contribute to choroidal thinning in eyes with staphyloma.

Strength and Limitations

The present study is one of the most large-scale, prospective studies conducted to investigate the topography and predictors of PPCT in myopic subjects. Unlike other studies, our study included a control group and therefore we could examine the differences between highly myopic eyes and nonmyopic eyes in our cohort. It involved a group of young, healthy, male, Asian subjects of uniform age and was thus free of confounding factors. However, these features may limit the application of these data to females and subjects of other groups or ethnicities. Further studies in other ethnic populations are warranted to confirm the results. Another limitation is that the cause–effect relationship cannot be ascertained due to the cross-sectional nature of our study. Recently, diurnal fluctuation of choroidal thickness was reported[34] and this could have impacted our results, though any impact of diurnal variation should be randomly distributed among myopic and emmetropic eyes.

Conclusions

There are regional differences in terms of distribution of PPCT. Peripapillary choroid was significantly thinner in the more myopic eyes over a range of eccentricities and follows a different profile compared with emmetropes. Axial length, IOP, presence of posterior staphyloma, and chorioretinal atrophy are the significant factors associated with PPCT in high-myopia eyes and must be taken into consideration when interpreting these data. Knowledge of normal PPCT and its profile in young, high myopes and emmetropes may aid in the understanding of physiological and pathological changes of peripapillary chorioretinal conditions.

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