Retinal Sensitivity and Depolarization Measured by Polarization-Sensitive Optical Coherence Tomography in Patients with High Myopia

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Purpose
Retinal sensitivity may decrease in high myopia even without choroidal neovascularization or patchy chorioretinal atrophy. The association between retinal sensitivity and the integrity of retinal pigment epithelium (RPE) has not been studied in detail. In the present study, we investigated the association between retinal sensitivity and optical depolarization at the RPE layer measured by Polarization-Sensitive Optical Coherence Tomography (PS-OCT) in patients with high myopia.

Methods
Among patients who visited at University of Tokyo Hospital, 23 highly myopic eyes (age, 66.6±12.3) without history of choroidal neovascularization or patchy chorioretinal atrophy, were included. High myopia was defined as a refractive error of less than -8.0 diopters (D) or an axial length of 26.5 mm or longer. Retinal sensitivity was measured by microperimetry in 25 points within 8 degrees from the fovea. Depolarization was measured by a clinical prototype of PS-OCT. RPE layer was automatically segmented and enface depolarization map was exported. 25 sectors corresponding to the point measured by microperimetry was overlaid to the depolarization map and the mean value in each sector was calculated. We used mixed model to investigate the association between retinal sensitivity, age, axial length, degree of depolarization in the RPE, choroidal thickness, and retinal thickness.

Results
The average and deviation of retinal sensitivity, axial length, choroidal thickness, and retinal thickness was 25.3±1.7dB, 29.6±1.6mm, 82.5±30.7µm and 263.0±33.9µm, respectively. Axial length (β=-0.53 [-0.92 to -0.13], p=0.01), degree of depolarization in the RPE (β=5.0 [1.1 to 9.0], p=0.01)
and retinal thickness (β=0.0057 [0.00077 to 0.011], p=0.02) were significantly associated with retinal sensitivity. **Conclusions**

Retinal sensitivity and depolarization in the RPE measured with PS-OCT may be associated in patients with high myopia. **Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.**

Retinal sensitivity may decrease in high myopia even without choroidal neovascularization or patchy chorioretinal atrophy. In previous studies, thinning of choroid was associated to decrease of retinal sensitivity. RPE must be playing important role because it feeds photoreceptor, but it was difficult to measure the integrity of RPE before PS-OCT appeared. In the present study, we investigated the association between retinal sensitivity and depolarization at the RPE layer measured by PS-OCT in patients with high myopia.
Axial length and Axial length/Corneal Curvature percentiles for Chinese cohort aged 4 to 18 years

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DisclosureBlock: Padmaja Sankaridurg, Brien Holden Vision Institute Code E (Employment), Brien Holden Vision Institute Code P (Patent), International Myopia Institute Code S (Non-remunerative), Thomas Naduvilath, Brien Holden Vision Institute Code E (Employment), Xiangui He, None; Jianfeng Zhu, None; Haidong Zou, None; Xun Xu, None;

Purpose
To establish percentile curves for axial length (AL) and axial length/corneal curvature (AL/CR) by age and determine the influence of gender in Chinese children and young adults.

Methods
Retrospective analysis of data on AL, cycloplegic spherical equivalent (SE) and corneal curvature of 14127 Chinese participants aged 4 to 18 years from 3 studies conducted in Shanghai, China. AL and AL/CR percentiles were estimated using Lambda-Mu-Sigma method and compared for agreement using intra-class correlation (ICC). Logistic regression was used to model the risk of myopia based on age and percentiles. Area under ROC curve was used to compare model predictability.

Results
For the 14127 participants (9.4±4.0 yrs, Males 54%), SE was -0.76±2.53D (-13-+9D), AL was 23.7±1.4 (18.3-30.4 mm), CR was 7.85±0.25 (7-9.5 mm). Myopia (≤-0.5D) was present in 42.3% and increased with age. ICC between AL and AL/CR percentiles was moderate (ICC=0.575), low in younger children (ICC=0.19, 4yrs) and steadily increased with age (ICC=0.78, 17yrs). The 10, 50, 90 and 97th percentiles for AL and AL/CR at 4, 6, 10, 15 and 18 yrs are listed in the table. For AL, males were at a higher percentile compared to females (61st / 34th, 53rd / 41st, 49th / 44th percentiles at ages 4,10 and 18 years respectively). However with ALCR, gender differences reduced (55th / 45th, 51st / 48th, 47th / 48th for males / females) at ages 4, 10, 18 years respectively. A greater separation by gender was evident at younger ages for both AL and AL/CR. Logistic model based risk of myopia resulted in 94% and 97% area under ROC curve for AL and AL/CR, respectively. Compared to AL/CR, AL percentiles predicted a higher risk of myopia at 18 yrs for those in the lower percentiles. By 18 yrs, AL & AL/CR percentiles ≥10 were associated with a >66% and >50% risk of myopia respectively, while percentiles ≥75 were associated with a ≥40% & ≥31% risk of high myopia.

Conclusions
Age and gender specific percentiles provide reference data for monitoring refractive errors in children aged 4 to 18 years from China. Furthermore, AL/CR percentiles may predict the probability of myopia better than AL.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
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The short-term effect of diffuse and defocus blur on axial length and vision

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DisclosureBlock: Swee Chai Teoh, None; Michael J. Collins, None; Scott A. Read, None;

Purpose
It is not clear what aspects of the retinal image are important for guiding eye growth in humans. This study investigates the axial length (AxL) changes with short-term exposure to different types and levels of blur (both diffuse and defocus blur).

Methods
This experiment involved 20 participants (7 males, 13 females), aged 20 to 41 years, and right eye mean spherical equivalent refraction of -0.46 ± 0.93 D (range: +0.50 D to -2.63 D). At each of five visits, axial length measurements of the right eye were taken with the Lenstar LS 900, before blur exposure (baseline), and after 10, 20 and 30 min exposure to blur. Subjects watched TV at 5 m binocularly with the right eye exposed to blur while the left eye had clear vision. Blur conditions included: Bangerter foil density 0.2 (BF0.2), Bangerter foil light perception (BFLP), +2.25 D, BF0.2 combined with +12.50 D (BF0.2/+12.50D) and a control condition (no diffuser). Right eye visual acuity (VA) was measured with all blur conditions using the FrACT vision test.

Results
AxL changed significantly with blur conditions (F₄,₇₆ = 9.36, p < 0.00001), with no significant time by blur condition interaction (F₈,₁₅₂ = 1.15, p = 0.33). Post-hoc testing with Bonferroni correction showed that the +2.25 D condition significantly shortened the AxL compared to the other blur conditions (p < 0.05). AxL with +2.25 D was -7 ± 2 µm shorter compared to BF0.2 (p = 0.03), even though both conditions caused an equal loss in VA. The BF0.2 and BFLP produced similar, non-significant AxL changes, while BFLP caused 0.28 ± 0.02 logMAR greater VA loss than BF0.2 (p < 0.0001). The AxL changes with the BF0.2/+12.50 D condition and the control condition were not significant (+0.5 ± 1 µm, p = 1.00).

Conclusions
The myopic vergence appears to explain the axial length shortening in myopic defocus blur compared to diffuse blur that produced equivalent VA loss. Further investigation is required to understand the interaction of diffuse and defocus blur, and the role of the retinal image spatial and contrast information in regulating short-term axial length changes.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
This study investigates how eyeballs change in different types and levels of blur. Outcomes from this study will benefit the understanding of the possible mechanism underlining the development of short-sightedness when the eye is exposed to short-term blurred vision.
Capillary perfusion of superficial retina and hemodynamics of central retinal artery in myopic eyes

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DisclosureBlock: Mei ZHAO, None; Andrew K.C. Lam, None; Lu Ning Qin, None; Michael Ying, None; Allen M Y Cheong, None;

Purpose
Recent studies have shown that myopic eyes had reduced capillary perfusion of the superficial retina measured by Optical Coherence Tomography Angiography (OCTA). Blood supply of the superficial retina is originated from the central retinal artery (CRA), in which reduced blood flow velocities and increased blood vessel resistance in myopic eyes were also observed by Color Doppler Ultrasound (CDU). This cross-sectional study aimed to examine the association between impaired capillary perfusion and compromised CRA hemodynamics in myopes.

Methods
108 young healthy subjects (68 female and 40 male) aged from 18 to 40 and refractive errors of -0.25 to -15.38D were recruited. Subjects with systemic or ocular diseases which might affect ocular blood circulation were excluded. Axial length (AL) was measured by the IOL master. A 3 x 3 mm OCTA image centered on the fovea was captured using the Cirrus HD-OCT and perfusion densities of the superficial retina were calculated based on a 3mm-Early Treatment Diabetic Retinopathy Study grid. Hemodynamic characteristics (peak velocity, mean velocity, pulsatility index, PI, resistance index, RI) of the CRA were measured by MyLab™ Twice CDU with a linear transducer. Blood pressure and pulse were recorded by an electronic sphygmonanometer.

Results
With an increase in AL, global perfusion density of the superficial retina (r = -0.33, p < 0.001), peak velocity (r = -0.22, p = 0.02) and mean velocity (r = -0.21, p = 0.03) of the CRA significantly decreased while the pulsatility and resistance indices remained unchanged. No significant correlation between the global perfusion density and hemodynamics characteristics of CRA was found after controlling for AL (all p > 0.05). However, results from generalized linear model showed that PI (B = 2.24, p = 0.03) and RI (B = 8.81, p = 0.01) were significant positive predictors of the perfusion density at the superior retinal region.

Conclusions
In line with previous studies, both global perfusion density of superficial retina and blood flow of CRA were reduced in myopes. However, no causal relationship was found between reduced superficial capillary perfusion and compromised blood supply of CRA. Decreased CRA blood velocity does not necessarily lead to reduced blood volume entering the eye. The vessel lumen should be taken into consideration when examining the relationship between perfusion density and CRA hemodynamics.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Scotopic and Mesopic Retinal Sensitivity in Pathologic Myopia

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DisclosureBlock: Takayuki Baba, Novartis Code F (Financial Support), Takehito Iwase, None; Tomohiro Nizawa, None; Shuichi Yamamoto, Santen Code F (Financial Support), Jamecs Code F (Financial Support)

Purpose
We investigated the relationship between the retinal morphology and the retinal sensitivity in the eyes with pathologic myopia. The scotopic and mesopic retinal sensitivities were recorded, and the association of these sensitivities was also investigated.

Methods
We included nine eyes of 5 cases in this retrospective study. The total retinal thickness and the presence of the ellipsoid zone (EZ) were determined using the radial scans of spectral-domain optical coherence tomography (OCT). The observation was made at 37 points of 6 scans corresponding to the locations where the retinal sensitivities were measured. The scotopic retinal sensitivity was determined by MP-3 (NIDEK, Japan) with a background luminance of 4 abs after dark adaptation for 15 minutes. The mesopic retinal sensitivity was then recorded with a background luminance of 31 abs. All of the 37 measured points located within the ETDRS grid. The relationship between the retinal structure (retinal thickness, presence of ellipsoid zone) and the mesopic and scotopic retinal sensitivity was determined.

Results
The average age of patients was 72.0 ± 5.5 years old. The average axial length of the studied eyes was 28.2 mm. A total of 333 points was measured by OCT and MP-3. The scotopic and mesopic retinal sensitivities at the points with EZ were significantly higher than those at the points without EZ (P <0.01, P <0.01, respectively). The scotopic retinal sensitivity (mean; 16.5 dB) was lower than the mesopic (mean; 20.7 dB), and correlated with the mesopic retinal sensitivity (P <0.01, r =0.73). The difference in the retinal sensitivity between the presence and absence of EZ was greater in the scotopic sensitivity. There was no relationship between the total retinal thickness and the scotopic and mesopic retinal sensitivities (P =0.591, P =0.117, respectively).

Conclusions
In pathologic myopia, the presence of EZ closely associated with high retinal sensitivity. The scotopic retinal sensitivity had a greater difference between the presence and absence of EZ than mesopic sensitivity. The scotopic microperimetry may be a more sensitive test to evaluate retinal function.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Time Outdoors, Near Work, and Electronic Device Use in Israeli Children

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DisclosureBlock: Ariela Gordon-Shaag, None; Einat Shneor, None; Ravid Doron, None; Jonathan Levine, None; Lisa Ostrin, None;

Purpose
Outdoor time and near work are risk factors for myopia. There is recent concern that electronic device use may also contribute to myopia. Evidence supporting the contributions of these risk factors is equivocal. Previous studies have reported a high prevalence of myopia in young adult ultra-Orthodox males, possibly attributed to educational demands requiring intense near work from a young age. This study aimed to assess visual activity in three groups of Israeli Jewish children with highly homogenous genetics, but vastly different behaviors.

Methods
Twenty-eight healthy boys, ages 8-10, were recruited from ultra-Orthodox (n=13), religious (n=8), and secular (n=7) backgrounds. A complete eye exam with cycloplegic autorefraction (L80, Luneau, FR) was performed. An Actiwatch was dispensed for children to wear for 7-10 days for objective measures of light exposure and physical activity. Reading, writing, and electronic device use were assessed with a custom questionnaire. Time outdoors was quantified as minutes per day exposed to >1000 lux. Data were analyzed with Kruskal Wallis tests and Bonferroni post hoc comparisons.

Results
Data show that refraction tended to be more myopic in ultra-Orthodox boys (-1.01±1.27 D), although not significantly different than religious (-0.63±1.27D) or secular boys (+0.10±0.32D, P=0.31). Ultra-Orthodox boys learned to read at a significantly younger age (4.38±0.77 years) than religious (5.88±0.35 years, P=0.002) and secular boys (6.14±0.38 years, P<0.001). Ultra-Orthodox boys had significantly less electronic device use than secular boys (0.44±0.62 and 4.52±1.01 hours, respectively, P=0.002), and significantly more reading and writing time than secular boys (2.71±2.10 and 0.78±0.53 hours, respectively, P=0.006). Actigraph data showed that there were no significant differences in daily activity (P=0.64) or time spent outdoors (P=0.51) between groups.

Conclusions
These preliminary findings demonstrate that ultra-Orthodox, religious, and secular boys exhibit distinct behaviors. These behaviors may contribute to previously reported differences in refractive error between groups. Findings suggest that increased near work could be the myopiogenic factor in the ultra-Orthodox population, as opposed to time outdoors or electronic device use. Ongoing data collection to increase sample size will help to confirm this hypothesis.

Layman Abstract (optional):
Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Further clinical, genetic and epigenetic evidence of multifaceted high myopia etiology in Polish patients

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**DisclosureBlock:** Joanna Swierkowska, None; Justyna A. Karolak, None; Małgorzata Rydzanicz, None; Agata Frajdenberg, None; Małgorzata Mrugacz, None; Monika Podfigurna-Musiela, None; Sangeetha Vishweswaraiah, None; Uppala Radhakrishna, None; Marzena Gajecka, None;

**Purpose**
High myopia (HM) is an eye disorder characterized by a refractive error greater than -6.0 dioptres and axial length (AL) more than 26.0 mm. While the involvement of genetic factors in HM etiology has been discussed in the literature, no general conclusions about genetic basis of HM has been made so far. To date, we identified three novel loci for HM in Polish families (PMID:21850178), showed no association between previously published candidate genes and HM in Polish subjects (PMID:21976954), and identified novel missense variants, c.1642G>C in *FLRT3* and c.938C>T in *SLC35E2B* in familial HM. Recently, we conducted the genome-wide methylation study in Polish children with HM and matched controls (PMID:30858441). Here we present further experimental analyses indicating the complexity of HM’s genetic background.

**Methods**
We performed additional analyses of exome sequencing data obtained from 17 members of seven unrelated Polish HM families and a validation by Sanger sequencing and segregation analyses in other family members. Moreover, the statistical assessment of clinical data and validation of chosen, based on the literature data, sequence variants influencing the value of AL, intraocular pressure (IOP), and corneal curvature (CC) were performed in four Polish HM families. Furthermore, based on the genome-wide methylation results, we performed molecular pathways overrepresentation analyses using the ConsensusPathDB.

**Results**
Further evaluation of exome sequencing results revealed segregation of c.3704G>A in *ABCC6* with familial HM. The assessed sequence variants did not contribute to AL, IOP, CC in Polish HM subjects. Hypermethylated CpG dinucleotides in promoter regions of genes *GSTM1*, *PPP1R18*, *TRAPPC11*, *XRCC2*, *OXA1L*, *FARP2*, and hypomethylated in genes *ABHD13*, *SORBS2*, *SLC25A3P1*, *TANC1*, *ATXN1*, and several overrepresented pathways related to myopia were identified.

**Conclusions**
Results suggest that *ABCC6* variant might contribute to HM in Polish family, but other than analyzed sequence variants contribute to AL, IOP, and CC in the studied families. Identified hyper- and hypomethylated genes could influence gene expression and take part in HM pathogenesis in Polish children. Our results further indicate the complexity of genetic background of HM in Polish subjects.

**Layman Abstract (optional):** Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
High myopia (HM), an eye disorder characterized by a refractive error greater than -6.0 dioptres and axial length more than 26.0 mm, is a major cause of blindness in developed countries. HM is a complex trait of multifactorial etiology, including genetic and environmental factors as near work, artificial light exposure, lack of physical activity outdoors, and a higher level of education. Thus far, number of genetic alterations specific to populations and even families have been identified. Here we present further experimental analyses indicating the complexity of HM’s etiology. Studies on blood DNA obtained from Polish HM subjects and matched controls were performed. Results suggest that \textit{ABCC6} variant might be responsible for HM in the Polish family, but other than analyzed sequence variants contribute to axial length, intraocular pressure, and corneal curvature in the studied families. Identified changes in methylation level could influence gene expression and take part in HM pathogenesis in Polish children. Our results further indicate the complexity of HM genetic background in Polish subjects, and may be of interest to ophthalmologists and researchers. Identification of new HM causes increases the understanding of its molecular mechanisms and is a step towards better molecular diagnostics and potential treatment in HM.
A multi-generational family affected by cavitary optic disc anomaly

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DisclosureBlock: Bradley Jacobsen, None; Moussa A. Zouache, None; Margaret M. DeAngelis, None; Paul S. Bernstein, None;

Purpose
An optic nerve pit (ONP) is an excavation of the optic disc that usually presents unilaterally and in the inferotemporal quadrant of the nerve head (Figure 1). Vision loss attributable to ONPs manifests as an adult-onset maculopathy secondary to a serous retinal detachment or cystoid macular edema. There are no particular risk factors, however, there have been reports that demonstrate an autosomal dominant inheritance pattern. The term cavitary optic disc anomaly (CODA) describes an autosomal dominant pedigree with a range of optic disc abnormalities.

Methods
Eight affected and ten unaffected family members of a multi-generation pedigree were phenotyped by visual acuity, intraocular pressure, dilated fundus examination, fundus photography, and optical coherence tomography (Figure 2). Whole genome sequencing was performed on five individuals (four affected and one unaffected).

Results
This multi-generation pedigree contains at least 4 generations of individuals affected with CODA. Whole genome sequencing revealed that the affected individuals do not have the same copy number alteration (CNA) described in previous studies.

Conclusions
Until recently it has been suggested that most optic nerve anomalies are congenital. However, recent studies have shown that, in fact, CODA is an inherited optic disc anomaly. This is important as certain therapies can be directed at preventing maculopathy leading to improved visual outcomes. We hope that our study will further the knowledge of CODA. Future work will focus on analyzing the genetic data for these patients to hopefully identify a unique genetic mutation.

Layman Abstract (optional):
Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
A microperimetric evaluation of macular function in highly myopic eyes with myopic macular degeneration.

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**DisclosureBlock:** Qiu Ying Wong, None; Yee Shan Dan, None; Daryle Jason Go Yu, None; Quan V. Hoang, Johnson and Johnson Vision Care Code F (Financial Support), Chee Wai Wong, Johnson and Johnson Vision Care Code F (Financial Support)

**Purpose**
To evaluate the macular function in highly myopic eyes using microperimetry, and to correlate macular sensitivity with axial length (AL), best corrected visual acuity (BCVA) and the severity of myopic macular degeneration (MMD).

**Methods**
This is a clinic-based observational study of 49 eyes of 26 patients with AL ≥ 26.5 mm, enrolled from the high myopia clinic of the Singapore National Eye Centre. AL and anterior chamber depth (ACD) were measured with the IOLmaster. Myopic maculopathy (MMD) was graded from fundus photographs according to the META-PM Classification. Absence of MMD was defined as META-PM category <2, mild MMD as META-PM category 2 and severe MMD as META-PM category 3 or 4. Microperimetry was performed to measure macular sensitivity (MS) at central 6 degrees and 2 degrees. We analyzed the correlation of MS at these points to AL, logMAR BCVA and compared MS across different MMD categories.

**Results**
The mean age was 64.2±10.1 years, mean AL was 29.2±3.0mm and mean logMAR BCVA was 0.55±0.65. 3 (6.1%), 6 (12.2%), 20 (40.8%), 14 (28.6%) and 6 (12.2%) eyes were graded as meta PM categories 0, 1, 2, 3 and 4 respectively. MS at 2 and 6 degrees were strongly correlated with AL (r= -0.52 and -0.59 respectively) and BCVA (r= -0.59 and -0.68 respectively). Compared to eyes with no MMD (26.7±1.9), MS at 2 degrees was significantly worse in eyes with mild (22.0±1.3, p=0.05) and severe MMD (19.8±1.5, p=0.007). MS at 6 degrees was significantly worse in eyes with mild (22.8±1.1, p=0.04) and severe MMD (19.1±1.3, p=0.001) compared to eyes with no MMD (26.9±1.6). In contrast, logMAR BCVA was significantly different only between eyes with severe and mild MMD (0.75±0.15 vs 0.32±0.15, p=0.05).

**Conclusions**
Macular sensitivity decreased with increasing axial length and worsening severity of MMD. Macular function as measured by microperimetry may be a more sensitive marker of visual function than visual acuity in eyes with MMD.

**Layman Abstract (optional):** Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Complications of pathologic myopia in extremely long eyes ≥30.0mm and their impact on vision

Purpose
To describe the prevalence of complications associated with pathologic myopia in extremely long eyes of axial length (AL) ≥30.0mm, and assess their impact on vision

Methods
This is a clinic-based observational study of 78 eyes of 49 patients with AL ≥ 30.0 mm, enrolled from the high myopia clinic of the Singapore National Eye Centre. AL and anterior chamber depth (ACD) were measured with the IOLmaster. Myopic maculopathy (MMD) was graded from fundus photographs according to the META-PM Classification and defined as META-PM category ≥ 2. Swept source optical coherence tomography of the macula and optic nerve was performed and examined for the presence of retinal and optic disc lesions. The diagnosis of glaucoma was made by a fellowship trained glaucoma specialist. The prevalence of each of these lesions were described and the impact of MMD, MTM and glaucoma on visual acuity were assessed.

Results
The mean age was 58.3±9.1 years, mean AL was 31.9±1.4mm and mean logMAR BCVA was 0.34±0.27. The majority of patients were female (n=35, 71.4%). MMD was detected in 72 (92.3%) eyes: 39 (50.0%) were graded as META-PM category 2, 28 (35.9%) as META-PM category 3 and 5 (6.4%) as META-PM category 4. MTM was found in 21 eyes (26.6%) and the most common lesion was extrafoveal macular schisis (n=15, 20.0%). Glaucome was diagnosed in 8 eyes (10.3%), of these, primary open angle glaucoma (3 eyes) and secondary glaucoma (3 eyes) were the most common, followed by normal tension glaucoma (2 eyes). Mean logMAR BCVA was 0.46±0.50, 0.63±0.63 and 0.32±0.22 in eyes with MMD, MTM and glaucoma respectively. BCVA worsened with increasing number of PM complications (0.32±0.10, 0.36±0.36 and 0.64±0.65 for 0, 1 and 2 complications respectively, p=0.001). Compared to glaucoma and MMD, MTM had the greatest impact on visual acuity on multivariate analysis adjusted for age, gender and AL (p=0.03).

Conclusions
Extremely long eyes with AL≥30.0mm had a high prevalence of MMD, MTM and glaucoma. Compared to glaucoma and MMD, MTM had the greatest impact on visual acuity in these eyes.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Retinal and foveal shape integrity is preserved in myopia.

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**DisclosureBlock:** Arne Ohlendorf, Carl Zeiss Vision International Code E (Employment), Katharina Breher, None; Kerstin Studtrucker, None; Siegfried Wahl, Carl Zeiss Vision International Code E (Employment)

**Purpose**
Different models were developed in order to describe the growth of the juvenile eye during the development of myopia, with the possibility of affecting the retinal shape, retinal thickness and foveal pit morphology. The current study compared these parameters between emmetropes and myopes from distortion-corrected swept-source OCT scans.

**Methods**
A 12x12 mm volume scan and a 16 mm horizontal HD line scan were performed on the right eyes of \(n = 38\) young adults (19 emmetropes and 19 myopes) using a swept-source OCT (PlexElite 9000, ZEISS Meditec, USA). The line scans were corrected for scan display distortions via an optical model including the ocular and OCT optics (OpticStudio, ZEMAX, LLC., USA). The retinal radius of curvature was calculated and foveal pit width, depth and slope were analyzed via a Sum of Gaussian function from the set of corrected scans. The total central retinal thickness was evaluated using the distance between the inner limiting membrane and the retinal pigment epithelium obtained by segmentation of the volume scans. Differences in retinal curvature, foveal pit shape and retinal thickness were compared between emmetropes and myopes.

**Results**
There was no statistical difference in horizontal retinal curvature between emmetropes and myopes with radii of 13.19 ± 1.76 mm and 13.55 ± 1.83 mm, respectively. Foveal pit width (1.23 ± 0.25 mm vs. 1.17 ± 0.14 mm), depth (0.11 ± 0.03 mm vs. 0.11 ± 0.02 mm) and slope (13.43 ± 3.28° vs. 13.96 ± 2.51°) neither revealed any significant differences between refractive groups. The same applied to central retinal thickness, which neither differed between emmetropes and myopes with 272.11 ± 31.29 µm and 283.26 ± 26.57 µm.

**Conclusions**
Analysis of the wide-field swept-source OCT scans showed no clinically relevant differences between myopes and emmetropes for the evaluated parameters. Therefore, these parameters might not serve as potential in-vivo biomarkers for myopia. Future longitudinal studies could analyze these parameters in children to evaluate a potential re-organization of the retinal tissue during myopia progression between childhood and adolescence.

**Layman Abstract (optional):** Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Time of the day and influence of optical defocus on the eye length and choroidal thickness

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**DisclosureBlock:** Ingrid Ornella Mekountchou Koumbo, None;

**Purpose**
Diurnal variations in ocular parameters have been reported previously. The present study reports the effects of short-term optical defocus on central and peripheral eye length and choroidal thickness as observed during the day (7-11 a.m. [morning] and 5-8 p.m. [evening]).

**Methods**
Healthy young subjects aged 18 - 25 years were exposed to 30 min of continuous myopic (+3.00D), hyperopic (-3.00D) and multifocal defocus (Plano/+2.50D addition) lenses in the right eye only (n=10). Eye length and choroidal thickness were measured at central and peripheral locations out to 20° field angles. For each scheduled visit, two baseline assessments were conducted 30 min apart. Thereafter, the defocus lens was introduced and a measurement conducted after 30 min. Between measurements, subjects watched a movie at 4 m distance under normal indoor lighting conditions. Each participant attended six visits. Repeated measures ANOVA was used to determine the change from baseline with the time of day and lens as within-subject factors. Statistical significance was maintained at $p<0.05$.

**Results**
Between the two baseline measurements, there were no statistically significant changes. Exposure of central and peripheral eye length to defocus showed statistically significant changes in the evening only. Centrally, there was a significant difference between lens types ($p=0.002$) and between the time of day ($p=0.001$). Myopic and multifocal defocus led to a significant decrease in the evening (-25±13 and -21±9 µm) as compared to the morning (-7±11 and -7±16 µm). Myopic and multifocal defocus significantly decreased (-16±8 and -14±10 µm) compared to hyperopic defocus (1±10 µm). Peripheral locations also showed some statistically significant changes at temporal 10°, nasal 10° and inferior 20°.

For choroidal thickness, there was a statistically significant change between defocus irrespective to the time of the day ($p=0.041$). At the center, only myopic defocus had a significant decrease (-14±18 µm) compared to hyperopic (+4±13 µm) and multifocal defocus (+6±13 µm). Peripherally, there were some statistically significant changes at nasal 10°.

**Conclusions**
Our preliminary data support the trend for diurnal changes in eye length. Interestingly, the effects of optical defocus could be modulated based on the time of the day. These findings, if consistent for a larger sample, have implications on the use of myopia control strategies.

**Layman Abstract (optional):** Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Effect of temporary full-field defocus on ocular biometric components and their subsequent normalization: a pilot study

**AuthorBlock:** Ryo Kubota¹, Nabin R. Joshi², arkady selenow², amitava gupta¹, steven ali², inna samandarova², maksud oliva², Kenneth J. Ciuffreda³

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**DisclosureBlock:** Ryo Kubota, Acucela Inc Code S (Non-remunerative), Nabin R. Joshi, None; arkady selenow, Acucela Inc Code C (Consultant), amitava gupta, Acucela Inc Code E (Employment), steven ali, None; inna samandarova, None; maksud oliva, None; Kenneth J. Ciuffreda, None;

**Purpose**
In this pilot study, we observed the effects of temporary full-field defocus on axial length and other components of the eye, and their normalization for up to half an hour following the removal of defocus.

**Methods**
15 visually-normal subjects (9 females and 6 males) of mean age 25.70 years (range 21-32) with spherical refractive error within ± 2.0 D and cylinder less than 0.75 D were enrolled in the study, confirmed with cycloplegia (Cyclopentolate 1%). 11 out of 15 subjects were of Asian ethnicity. The subjects underwent 3 separate defocus sessions under controlled conditions viewing distance tasks. For the first session, a defocus of +2.0 D was applied to the non-dominant eye with a distance refractive correction in the dominant eye with standard spectacle lenses for 2 hours (hrs). The same subjects underwent defocus sessions under controlled conditions with +3.50 D of defocus for 4 hrs, and +5.0D of defocus for 6 hrs, each after washout periods. Data collection for these two sessions is ongoing, including analysis of choroidal thickness measurements obtained from Heidelberg SD-OCT with EDI, which will be presented. The abstract deals with the first defocus session with only the non-dominant eye defocused by +2.0D. Axial length was measured with a Lenstar APS 900 from Haag-Streit Holding before the defocus sessions, immediately after, and twice after in a 15-minute interval.

**Results**
The mean percent increase of axial length relative to the baseline following defocus for the test eyes was +0.004% with a SD of 0.05, and it was +0.03% (SD ± 0.05) for the control eyes with rank-sum test significant at p<0.05. The coefficient of determination (r²) for the percent increase from baseline was 0.35 when the test eyes were plotted against control eyes immediately following defocus, which increased to 0.78 with p<0.01 after half an hour following defocus.

**Conclusions**
Percent increase in axial length from the baseline was smaller for the test eyes relative to the control eyes after 2 hours of full-field defocus. The correlation of change was normalized after half an hour following the removal of defocus. Growth signals generated by myopic defocus may reduce the axial length by attenuating its increase driven by diurnal rhythms, and could be of significant utility in myopia control strategies.

**Layman Abstract (optional):** Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Quantitative assessment of the choroidal vasculature in myopic macular degeneration with optical coherence tomographic angiography.

AuthorBlock: Bridget Ng, Yee Shan Dan, Marcus Ang, Leopold Schmetterer, Chee Wai Wong
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DisclosureBlock: Bridget Ng, None; Yee Shan Dan, None; Marcus Ang, None; Leopold Schmetterer, None; Chee Wai Wong, None;

Purpose
Choroidal thickness is associated with high myopia and myopic macular degeneration (MMD), but the specific vascular changes that occur within the choroid are unclear. We aim to assess and compare choroidal vascular parameters, using optical coherence tomographic angiography (OCTA), in highly myopic adults with and without myopic macular degeneration (MMD).

Methods
This is a clinic-based observational study of 128 eyes of 82 patients with axial length (AL) ≥ 26.5mm, enrolled from the high myopia clinic of the Singapore National Eye Centre. Myopic maculopathy (MMD) was graded from fundus photographs according to the META-PM Classification and defined as META-PM category ≥ 2. Swept source OCT (SS-OCT) and OCTA were performed and assessed for choroidal layers (overall choroidal thickness (CT), medium-vessel choroidal layer (MVCL) thickness, large vessel choroidal layer (LVCL)) and choroidal vasculature (choroidal vessel density (%), choroidal branch area (CBA, %) and mean choroidal vessel width (MCVW, mm)).

Results
CT (r=-0.58, p<0.001) and overall MCVW (-0.58, p<0.001) were negatively correlated with AL, while overall CBA (r=0.61, p<0.001) was positively correlated. Eyes with MMD had significantly lower CT (99±42um vs 189±81um, p<0.001), MVCL thickness (60±14um vs 74±20um, p=0.001), and overall MCVW (5.64±0.41um vs 5.94±0.41, p<0.001) than eyes without. Overall CBA (10.26±0.67 vs 9.75±0.62, p<0.001) was significantly higher in eyes with MMD than eyes without. After adjusting for age, gender and axial length, thicker CT (odds ratio (OR) 0.98, 95% confidence interval (CI) 0.97-0.99, p<0.001) and LVCL thinning (OR 0.97 95% CI 0.95-0.99 p=0.004) were significantly associated with lower odds of MMD.

Conclusions
Decreased choroidal vessel width and increased vascular branching were observed in eyes with long AL. A thinner choroid, particularly LVCL thinning, was associated with greater odds of MMD.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Location of the fovea and its ocular correlates in myopia.

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**DisclosureBlock:** Vinay Nangia, None; Alekhya Chhenamsetty, None;

**Purpose**
The location of the fovea is clinically important. It was the purpose to study the location of the fovea with respect to the optic disc margin and to determine its correlates with optic disc and retinal nerve fiber layer.

**Methods**
400 eyes of 200 subjects (108 females) were included. All subjects underwent an ophthalmic evaluation, biometry and fundus photography and SDOCT. The distance of the fovea to the disc margin temporally and distance to the margin of the PPA was measured using the caliper device in the spectralis. The mean age was 26.51+-12.04 yrs. Mean values for Visual Acuity Decimal units was 0.85+-0.24DU, sph. equivalent was -4.96+-3.52 D and axial length was 24.95+-1.41 mm. The horizontal and vertical disc diameters were 1538.67+-240.3 and 1608.55+-239.1.

**Results**
The mean fovea to disc angle was -7.0 +- 4.3 deg. Gamma zone PPA was seen in 178/400 eyes. The mean distance from fovea to disc margin was 3717.30+-378.94 u (range 2736-5039) from fovea to PPA margin was 3478.56+-357.33 u (range 2285-4356). The distance of fovea to center of disc margin temporally showed significant positive bivariate correlations with vertical diameter of disc (P=0.037;r=0.104), width of temporal gamma zone (P<0.001;r=0.551), distance from fovea to margin of PPA (P<0.001;r=0.611), keratometry readings vertical (P=0.013;r=0.126), temporal RNFLT (P<0.001;r=0.538), Naso inferior RNFLT (P=0.013;r=-0.124), Temporal inferior RNFLT (P<0.001;r=0.172), temporal superior (P=0.036;r=0.174), and negatively with horizontal DD (P=0.012;r=-0.126), sph.equ (P=0.001;r=-0.212) and anterior chamber depth (P=0.013;r=-0.126). On multivariate analysis with disc margin to fovea distance as dependant variable and all other significant variables as independent variable, correlations were seen with Temporal RNFLT (P<0.007; B: 0.693; 95% CI 8.84, 34.4), TI RNFLT (P=0.010; B: 0.455; 95% CI 3.38, 15.15), and width of temporal gamma zone (P=0.028; B:0.66; 95% CI 0.17, 1.93).

**Conclusions**
The distance of the fovea from disc margin was determined in myopia. The location of the fovea may differ significantly in myopic eyes and is significantly correlated in myopic eyes with the width of gamma zone and with the Temporal and Temporoinferior RNFLT. The distance of the fovea from the optic disc may be important from the clinical standpoint and has implications for the assessment of the RNFLT in glaucoma with myopia.

**Layman Abstract (optional):** Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Differing Optic Nerve Head Strains Comparing Low, High and Pathologic Myopia Eyes

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DisclosureBlock: Quan V. Hoang, Johnson and Johnson Vision Care Code F (Financial Support), Thanadet Chuangsuwanich, None; Daryle Jason Go Yu, None; Tin A. Tun, None; Chee Wai Wong, Johnson and Johnson Vision Care Code F (Financial Support), Xiaofei Wang, None; Zhi Yun Chin, None; Sripad Krishna Devalla, None; Dan Milea, None; Tin Aung, None; Michael J A Girard, Abyss Processing Pte Ltd Code P (Patent)

Purpose
To assess optic nerve head (ONH) strains (i.e. deformations) following adduction, abduction, and IOP elevation in healthy and highly myopic eyes (with and without pathologies).

Methods
We recruited 18 subjects, which comprised of 6 emmetropic or low myopia (LM), 6 highly myopia (HM: > 26 mm in axial length) and 6 pathologic myopia (PM = HM + staphyloma and/or macular degeneration). For each subject, we imaged the ONH using Spectral-domain optical coherence tomography (OCT) under the following conditions: (1) primary gaze, (2) 20° adduction, (3) 20° abduction, and (4) primary gaze with acute IOP elevation (to ~40 mmHg) achieved through ophthalmodynamometry. For each OCT volume, we automatically segmented the prelaminar tissue (PLT) and the lamina cribrosa (LC) using deep learning. We also digitally aligned the OCT volumes obtained from (2)-(4) to the baseline volume (1) before performing digital volume correlation (DVC) analysis to quantify IOP- and gaze-induced PLT and LC displacements for all scenarios. The resulting displacement fields obtained from the DVC analysis were then used to calculate the effective strain (a local measure of tissue deformation) that was compared across groups.

Results
IOP elevation generated abnormally high strains (6.6 ± 1.9%) in PM eyes as compared to HM eyes (3.4 ± 1.0%) and LM eyes (2.6 ± 0.8%). The same trend was also observed for eye movements. Interestingly, PM eyes experienced similar strains (no significance difference, p > 0.05) under IOP elevation (6.6 ± 1.9%) and adduction (6.4 ± 2.1%). In one subject with high axial anisometropia, the average strain in the PLT of the PM right eye (7.4 ± 2.3%) was much higher than that the LM left eye (4.3 ± 1.5%) under IOP elevation (p < 0.05).

Conclusions
We found that HM eyes tend to be more sensitive to IOP elevation as compared to LM eyes. PM eyes experienced abnormally high strains and they were equally influenced by IOP elevation and adduction. These preliminary results may indicate that ONH strain differs significantly between LM, HM and PM eyes and has the potential to serve as a biomarker for progression.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.

Myopia, or near-sightedness, is due to excessive eye elongation and is associated with changes in the strength and stiffness of the eye wall (sclera). We now have the ability to obtain high resolution images of the eye wall structures during light external pressure of a know force. We therefore imaged
key areas in the back of the eyes of patient with either low, high, or pathologic levels of near-
sightedness to compare the variation in eye wall strength, and hypothesize that this measure can
help predict which nearsighted eyes will continue to worse toward levels that experience permanent
vision loss versus remaining stable.
Influence of Greater Axial Length on Prevalence of Myopic Maculopathy in a Cohort of Highly Myopic Eyes

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DisclosureBlock: Daryle Jason Go Yu, None; Chee Wai Wong, Johnson and Johnson Vision Care Code F (Financial Support), Judith Ow, None; Yee Shan Dan, None; Qiu Ying Wong, None; Quan V. Hoang, Johnson and Johnson Vision Care Code F (Financial Support)

Purpose
To quantify the increased prevalence of myopic macular degeneration (MMD) and vision-threatening macular changes in highly myopic (HM) eyes with axial length (AL) ≥ 29.5 mm versus those with AL < 29.5 mm in a Singaporean cohort of HM.

Methods
A consecutive series of HM patients (< -6.00D and/or > 25 mm AL) clinically-diagnosed with staphyloma or MMD, were seen between 8/2019-11/2019. All patients underwent dilated retinal exam, AL measurement, fundus photography/autofluorescence and swept-source optical coherence tomography. The cohort was stratified into eyes with AL 25 to 29.5 mm and those > 29.5 mm.

Results
226 eyes of 120 HM patients (51.67% female, 59.5 ± 13.89 years-old, range 21-82) were evaluated. AL was 29.5 ± 2.4 mm (25.0 - 35.81 mm). Using the Meta-analysis of Pathologic Myopia classification to assess the MMD, the severity of MMD was higher in the longer AL group than the shorter AL group with 21.24%, 19.91%, 3.10%, and 4.87% of eyes in MMD Category 1, 2, 3 and 4 respectively in the short AL group versus 1.77%, 17.70%, 19.47% and 11.06% in the longer AL group. The longer AL group was found to have significantly higher prevalence of: foveoschisis 49.5% vs. 15.9% in the shorter AL group (Chi-square statistic 28.8107, p < 0.0001), vitreomacular traction 23.4% vs. 10.6% (6.5169, p = 0.0107), dome-shaped macula 16.2% vs. 4.4% (8.45, p = 0.0037), epiretinal membrane 31.5% vs. 14.3% (9.3997, p = 0.0022) and myopic choroidal neovascularization 23.4% vs. 9.7% (7.6093, p = 0.0058). The two groups did not differ in terms of past or present lamellar or full-thickness macular hole 12.6% vs. 8.8% (0.8289, p = 0.3626).

Conclusions
HM eyes with AL ≥ 29.5 mm have a higher prevalence of various vision-threatening myopic macular pathologies as compared to HM eyes 25-29.5 mm. This information adds to the database of knowledge of risk of vision loss associated with HM.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Axial length/corneal radius of curvature ratio (AL/CR) in children on atropine eye drops

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DisclosureBlock: Audrey Chia, None; Kai Lyn Loh, None; Cheryl Leow, None; Noel A. Brennan, None;

Purpose

It has been proposed that AL/CR may be more closely associated with spherical equivalent (SE) than axial length (AL) itself. Here, we study the relationship between the AL/CR and SE variables in children not on atropine, those on atropine for at least 1 year, and on treatment for more than 1 year.

Methods

Data from the first 100 children enrolled into the Prospective Myopia Study on children and teenagers (PROM-Kids) study were included in this study. Five factors, including children’s age, SE, AL, average keratometry (K)/corneal radius of curvature (CR) and years on atropine treatment were collected.

Results

Of the children recruited, 50 were male and 38 were not on atropine, 20 had been on atropine for < 1 year and 42 for > 1 year. Mean age was 9.6 years. As expected, older children and those with higher myopia had higher AL/CR ratios. Correlation between AL/CR and SE was tighter (R² 0.77-0.82) than between AL and SE (R² 0.55-0.60). A comparison showed no difference in the association in AL/CR ratio and SE between those in different categories of atropine use, in terms of slope and correlation. However, correlation between AL/CR and SE was also stronger than AL and SE in children on and off atropine. Multivariate analysis suggests that AL/CR may be strongly associated with SE rather than age after controlling for atropine use and gender.

Conclusions

These early baseline findings suggest that AL/CR may be a better variable to measure change in myopia than AL itself in children both on and off atropine treatment. There is great variability in change of SE and AL in children on atropine. Usefulness of change in AL/CR as a measure of myopia progression in children on atropine needs to be evaluated over time.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Parapapillary Choroidal Thickness in Myopia and its ocular and systemic co-relations

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DisclosureBlock: Swati Mishra, None; Vinay Nangia, None;

Purpose
The parapapillary choroid is a vascular tissue around the optic nerve. Choroidal thinning and atrophy is known to be associated with several retinal diseases that may affect the vision. In myopia choroidal thinning and its association with myopic macular degeneration is known to occur. The purpose of this study was to determine the PPCT in myopic eyes and to understand its correlations with optic disc and other ocular parameters.

Methods
171 eyes (98 female eyes) of 86 subjects were studied. All had axial length >23.5 mm. Subjects underwent eye evaluation and SD-OCT, using enhanced depth imaging. Subjects with poor images and coexisting ocular morbidity were excluded. For SD OCT a protocol was followed by doing A 360-degree 3.4 mm diameter parapapillary circle scan. Choroidal thickness was delineated as the area of visible choroidal vasculature between the RPE-Bruchs complex and the choroidal-scleral Interface. Correlation of RNFL and choroidal thickness measurements was assessed for each parapapillary location using Pearson correlation.

Results
Mean values were for age, 24.83±9.29 years, axial length was 25.05±1.17 mm. sph. equivalent -4.97±3.2, PPCT values were superior, 186.83±65.68 u, nasal, 164.85±58.57, temporal 167.39±71.58, and inferior, 138.29±51.46. Superior PPCT was found to correlate positively significantly with sph. equ. (P<0.001, r=0.344) BCVA (P<0.001;r=0.354) anterior chamber depth (P=0.007, r=0.207), presence of PPA (P<0.001, r=0.442), width of PPA (P<0.001, r=0.477), global RNFLT (P<0.001, r=0.352) and choroidal thickness at fovea (p<0.001; r=0.537). Negative significant correlations were found with axial length ( P<0.001; r=-0.355), Horizontal diameter of disc (P=0.001; r=-0.262), vertical diameter of disc ( P=0.016; r=-0.183) Similiar correlations were also seen with nasal, inferior and temporal PPCT. Paired T-test showed the superior, nasal and temporal PPCT to be significantly thicker than inferior PPCT P<0.001.

Conclusions
The peripapillary choroidal thickness in myopia was found to be significantly thinner inferiorly, compared to superior, nasal and temporal segments. PPCT was also found to correlate significantly with increasing global RNFLT and with the vertical and horizontal diameters of the optic disc. These correlations need to be further studied to understand their possible implications in subjects with glaucoma and myopia.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
A growth and remodelling model predicts the development of a staphyloma-like bulging of the posterior sclera due to high optic nerve traction during eye movements

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DisclosureBlock: Liam Kenneth Fisher, None; Fabian Albert Braeu, None; Xiaofei Wang, None; Dan Milea, None; Michael J A Girard, None;

Purpose
To establish whether a mechanically motivated model of growth and remodelling can explain the development of posterior staphyloma when optic nerve traction is applied to the globe by a horizontal eye rotation (adduction).

Methods
A three-dimensional finite element model of an eye was constructed. For simplicity, only connective tissues were modelled (corneo-scleral shell + lamina cribrosa). A circumferential arrangement of collagen fibres was embedded in the sclera surrounding the optic disc as is present physiologically. A simulated eye movement was used to induce a relatively high optic nerve traction force at the posterior pole of the eye (temporal quadrant), and the posterior sclera was permitted to grow and remodel in response to this constant loading. To predict the scleral growth in response to optic nerve traction during eye movements, we used a homogenized constrained mixture model of growth and remodelling, selected for its computational simplicity and its record of successfully modelling growth in other soft tissues. Changes in posterior scleral shape were then assessed qualitatively.

Results
The optic nerve traction at the posterior pole of the eye motivated growth, causing a staphyloma-like change in the morphology of the sclera adjacent to the optic disc. Both the clinical characteristic ‘outpouching’ of a scleral region with high curvature and the scleral ‘ridge’ that protrudes inwards at the temporal side of the optic nerve head were observed.

Conclusions
Under conditions of optic nerve traction in eye movements, a mechanically driven model of growth may provide an explanation for some cases of posterior staphyloma. A similar model could also potentially be used to explain other morphological aberrations such as axial elongation or tilted disc. Further work is needed to understand the material or geometric variation that would exacerbate this type of growth in specific individuals.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Choroidal thickness in central serous chorioretinopathy patients with a myopic refraction.

**Purpose**
Central serous chorioretinopathy (CSC) is part of the pachychoroid disease spectrum and is characterized by the presence of an increased choroidal thickness due to dilated choroidal vessels (pachyvessels) and choroidal hyperpermeability. In contrast, high myopia is usually accompanied with choroidal thinning. The goal of this prospective study was to compare imaging and clinical characteristics between myopic patients with CSC and healthy myopic controls and as well as emmetropic CSC patients.

**Methods**
We studied 31 eyes of 29 CSC patients with myopia (spherical equivalent (SE) ≤ -4 D or axial length (AL) ≥ 24.5mm), 83 eyes of 76 emmetropic CSC patients (SE between -0.5D and 0.5D) and 56 eyes of 56 healthy myopic controls, who were matched for age and AL. Median SE in myopic CSC eyes was -5.3D (IQR, -7.6 to -4.5D) and mean AL was 25.9±1.0mm. AL in healthy myopic eyes was 26.0±0.5mm. CSC was defined as subretinal fluid with leakage on late fluorescein angiography (FAG) and/or hyperpermeability on indocyanine green angiography (ICGA). Subfoveal choroidal thickness (SFCT) and the presence of pachyvessels were studied using enhanced depth imaging optical coherence tomography (EDI-OCT). Choroidal hyperpermeability was retrospectively analysed if ICGA was available. Clinical characteristics were studied in patient files. SFCT between groups was compared using a Kruskal-Wallis test.

**Results**
Median SFCT in myopic CSC eyes was 330μm (IQR, 228 to 380μm), which was significantly higher compared to SFCT in myopic controls (211μm (IQR, 171 to 247μm), p<0.001) and lower than in emmetropic CSC eyes (452μm (IQR, 342 to 538μm), p<0.001). Pachyvessels were found in 71% of myopic CSC eyes and 76% of emmetropic CSC eyes (p=0.6). Choroidal hyperpermeability was present in all 16 myopic CSC eyes that underwent ICGA. Age of disease onset (46±8 years, 44±9 years, p=0.2), acute episode of CSC (71%, 60%, p=0.6), ≥ 1 recurrence (42%, 52%, p=0.4) and secondary choroidal neovascularization (16%, 5%, p=0.06) were not significantly different between myopic and emmetropic eyes.

**Conclusions**
The subfoveal choroid of myopic CSC eyes is thicker than in myopic eyes without CSC. This study shows that high myopia and CSC can co-exist, and that myopic CSC typically shows clinical and imaging features that are very similar to emmetropic CSC. **Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated**
details.
Diagnostic exome sequencing in 50 patients with high myopia

**AuthorBlock:** Virginie Verhoeven¹², Annechien Haarman²³, Jan Roelof (JR) Polling², Marianne van Tienhoven¹, Alberta Thiadens², Sjoukje E. Loudon², Arjan Bouman¹, Anneke JA Kievit¹, Lies H. Hoefsloot¹, Caroline Klaver²⁴

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**Purpose**
High myopia (≤-6 diopters) represents a significant public health issue. The development of potential treatments make the understanding of the genetic etiology very important. High myopia is a heterogeneous condition, and without clear accompanying features it can be difficult to pinpoint a genetic cause. The aim of this study was to evaluate the diagnostic yield of whole exome sequencing (WES) in patients with high myopia.

**Methods**
Patients with high myopia were recruited by ophthalmologists and clinical geneticists. Clinical features were categorized into isolated high myopia, high myopia with other ocular features or syndromic high myopia with systemic involvement. WES was performed using a gene panel including 477 genes involved in inherited eye disorders.

**Results**
WES was performed in 50 patients with high myopia; the majority had isolated high myopia (64%). A genetic cause was identified in 11 patients (22%; mean age at diagnosis 9.4 years (SD 7.5); mean refractive error -12.60 diopters (SD 6.22)). Four patients had mutations in known retinal dystrophy genes (*GUCY2D; FAM161A; PDE6H; CACNA1F*); 3 female patients had a *ARR3* mutation (X-linked female limited high myopia); 2 patients had homozygous or compound heterozygous *COL18A1* mutations (Knobloch syndrome); 1 patient had a *COL2A1* mutation (Stickler syndrome); 1 patient had a *PAX6* mutation. In 14 patients (28%) a variant of unknown significance was found; further segregation or follow-up examinations are necessary.

**Conclusions**
The diagnostic yield of our WES vision gene panel for high myopia was 22%. It enabled us to diagnose various causes of high myopia, i.e. retinal dystrophies, connective tissue diseases, and non-syndromic high myopia, allowing appropriate follow up of systemic and ocular features and genetic counseling.

**Layman Abstract (optional):** Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Association of BSG genetic polymorphisms with myopia in a Han Chinese college student cohort

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DisclosureBlock: Juan Wang, None; Jieping Zhang, None; Lixia LYU, None; Guo-Tong Xu, None;

Purpose
Given the important role of basigin (BSG, CD147) gene and non-syndromic high myopia and eye elongation as reported, we speculated that BSG genetic polymorphisms might influence the formation of myopia. The study was to investigate the association between BSG gene polymorphisms and myopia in college student cohort.

Methods
A total of 158 myopia individuals (refraction ≤-3.00D, SE) and 124 normal controls (refraction between -0.50D and +2.00D, SE) college students participated in the association study. Allelic discrimination assay was performed on five single nucleotide polymorphisms (SNPs) (rs539913003, rs12611131, rs4919862, rs8637 and rs8259) in BSG by direct sequence analysis and restriction fragment length polymorphism (RFLP) of polymerase chain reaction (PCR) products. The genotype, allele and haplotype frequencies of the SNPs between cases and controls were compared by Chi-square test for association analysis.

Results
Significant differences were found in the genotypes and allele frequencies of the rs12611131 SNP between the myopia and control group, while the frequencies of the C allele and the CC genotype in the myopia group were significantly lower than those in the control group (P<0.05). There was no statistically significant difference in genotype, allele and haplotype frequencies for the other SNPs (rs539913003, rs4919862, rs8637 and rs8259) between the myopia group and the control group.

Conclusions
We do not find a strong evidence to support an association of SNP in BSG with myopia in the Chinese population studied.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Objective Measured Sleep Parameters in Non-Myopic and Myopic Adolescents

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**DisclosureBlock:** Lisa A. Ostrin, None; Scott A. Read, None; Stephen Vincent, None; Michael J. Collins, None;

**Purpose**
Previous studies, primarily using questionnaires, suggest a possible relationship between sleep and myopia. Sleep is known to be influenced by light exposure and physical activity. This study aimed to examine the influence of day of the week, season, time outdoors, and physical activity on objectively measured sleep parameters in non-myopic and myopic children.

**Methods**
Objective measures of light exposure, physical activity, and sleep were collected from 91 children aged 10 to 15 years using a wrist-worn actigraph device (Actiwatch 2) over two 14-day measurement periods approximately 6 months apart. Each measurement period was classified as either a longer day/warmer season or a shorter day/cooler season. Noncycloplegic subjective refraction was performed to classify children as non-myopic (spherical equivalent > -0.50 D, \( n = 55 \)) or myopic (≤ -0.50 D, \( n = 36 \)). Bed time, wake time, and sleep duration, latency, and efficiency were analysed with respect to season, day of the week (weekday vs weekend), age, gender, and refractive error. Influence of time spent outdoors and physical activity on each sleep parameter was also assessed.

**Results**
On weekends, children went to bed later (\( P < 0.001 \)), had increased sleep duration (\( P < 0.001 \)), and woke up later (\( P < 0.001 \)) than on weekdays. During the cooler season, children woke up later (\( P < 0.001 \)) and slept longer (\( P = 0.03 \)). Younger children (ages 10-12 years) went to bed earlier (\( P = 0.005 \)) and woke up earlier (\( P = 0.01 \)) than older children (ages 13-15 years). Compared to non-myopic children, myopic children had a longer sleep duration on weekends (\( P = 0.006 \)) and on cooler days (\( P = 0.01 \)). Additionally, myopic children had a shorter sleep latency on weekends (\( P = 0.005 \)). Children who were outdoors more tended to have increased sleep duration (\( \beta = 0.31, P = 0.03 \)), and children with greater physical activity tended to wake up earlier (\( \beta = -0.44, P < 0.001 \)).

**Conclusions**
Objectively measured sleep parameters, including bed time, wake time, and sleep duration, were significantly influenced by day of the week, season, and age. Light exposure and activity also demonstrated associations with sleep. Furthermore, myopic children tended to show more variation in sleep duration between days of the week and season than non-myopic children. Further investigation may help to clarify factors contributing to refractive error group differences.

**Layman Abstract (optional):** Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.

Previous studies, primarily using questionnaires, suggest a possible relationship between sleep and myopia. Sleep is known to be influenced by light exposure and physical activity. This study aimed to examine the influence of day of the week, season, time outdoors, and physical activity on objectively measured sleep parameters in non-myopic and myopic children. We found that bed time, wake time, and sleep duration, were significantly influenced by day of the week, season, and age. Light exposure and activity also demonstrated associations with sleep. Furthermore, myopic children tended to show more variation in sleep duration between days of the week and season than non-myopic children.
Further investigation may help to clarify factors contributing to refractive error group differences.
Baseline demographics and genetics from pivotal myopia management trial of a novel spectacle lens therapy

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Purpose
Millions of children are at risk of vision-threatening complications due to myopia, and new therapies are urgently needed. MYPI, a myopia genetic locus, is associated with splicing-defective cone opsin genes (OPN1LW and OPN1MW), leading to the hypothesis that contrast signaling in the retina plays an important role in myopia development and progression. This hypothesis predicts that reducing the contrast of images on the retina can slow myopia progression. Novel spectacle lenses were developed to evaluate this hypothesis, and a randomized, controlled clinical trial was designed to determine the safety and efficacy of this therapy.

Methods
CYPRESS (NCT03623074) was designed to evaluate two investigational spectacle lenses vs. control lenses for the ability to reduce myopia in children 6-10 years of age over a period of 3 years. The investigational lenses were designed to slightly reduce contrast in the periphery with no impact to on-axis vision. In a previous study, the investigational lenses were demonstrated to reduce high-contrast visual acuity on average by 0.5 and 1 line respectively when viewed off-axis. Two hundred and fifty-six (256) myopic subjects who met criteria were randomized and dispensed lenses at 14 sites. DNA was collected and cone opsin genes (OPN1LW and OPN1MW) were characterized as part of a program to identify myopia risk predictors.

Results
Subjects were 58% female with an average decimal age of 8.7 years (SD ± 1.2 years) at screening. The average spherical equivalent refraction (SER) was -2.01 D (SD ± 0.9 D) with a range from -0.75 to -4.50 D using manifest refraction and -1.94 D (SD ± 1.0 D) using cycloplegic autorefraction. Average axial length was 24.02 mm (SD ± 0.77 mm) at baseline. Variability in cone opsin haplotype was significantly higher (p = 0.02) in this sample of myopic children than in a larger, historic sample unselected for refractive error.

Conclusions
Novel therapeutic spectacles were designed to modulate peripheral retinal contrast in a viewing-distance independent manner, and an ongoing clinical trial, designed to support regulatory approval, is investigating the long-term safety and effectiveness. Baseline characteristics are appropriate for evaluating this new therapy. Subjects had high individual variability in cone opsin haplotypes, which is supportive of the hypothesis that rearrangements in the OPN1LW and OPN1MW genes leads to myopia.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.

New spectacles designed to reduce progression of nearsightedness in children are the subject of an ongoing government-registered, continent-wide clinical trial. Should this therapy be proven safe and effective, these spectacles may be cleared by the US Food and Drug Administration (FDA) as well as other regulatory bodies around the world. These spectacles, together with a genetic diagnostic test, may substantially alter the management of nearsightedness and lower the risk of the associated sight-threatening complications.
Change in Accommodation and Phoria in Children Treated with Multifocal Soft Contact Lens for Myopia Control

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DisclosureBlock: Harrison Feng, None; David Troilo, None; Xiaoying Zhu, Euclid Systems Corporation Code C (Consultant), Nevakar, Inc. Code C (Consultant), Brien Holden Vision Institute Code C (Consultant)

Purpose
Multifocal soft contact lenses (MFCLs) are used for myopia control with variable efficacies, potentially explained by reduced accommodation during MFCLs wear under experimental testing (Kang 2016; Gong 2017). In this study we present initial findings investigating the accommodative response and binocular posture over time in children treated with MFCLs for myopia control.

Methods
Subjects (no history of myopia control) were fit with Biofinity MFCLs with +2.00 D ADD and followed for up to 1 yr. MFCLs were worn for at least 10 hrs/d and 5 d/wk. Accommodative response to 3 stimuli (2, 2.5, and 4 D, monocularly measured with Grand Seiko open-field autorefractor) and phorias at distance and near (Modified Thorington) were measured with a Biofinity single vision (SVCLs) correction as a baseline and while wearing MFCLs at the initial fit and at several time points over one year.

Results
Ten subjects were initially enrolled (5 males, age 10.8 ± 2.3 yo, OD SE -3.16 ± 0.90 D). At initial fit, MFCLs significantly induced more exophoria (1.37 ± 5.74 PD) compared to SVCLs (0.04 ± 6.42 PD) at near (p = 0.03). Compared with SVCLs, MFCLs reduced accommodative gain for all 3 stimuli (MF – SV, 2 D: -0.24 ± 0.12, ns; 2.5 D: -0.22 ± 0.08, p < 0.05; 4 D: -0.17 ± 0.07, p < 0.05). No consistent change in accommodation or phoria was discovered during the 3-month follow-up period although some individuals appear to reduce gain over time in the graph.

Conclusions
MFCLs used on children for myopia management have an impact on the accommodation and phoria. Preliminary results in this study are consistent with previous clinical studies. Initial findings show that accommodative behavior while wearing MFCLs remain consistent in some individuals but shift in others. We speculate that this may help explain why some children respond better to treatment than others. More subjects and longer follow-up time are needed so that data can be correlated with treatment efficacy.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Pediatric Ocular Non-Contact Ocular Biometry Before and After Cycloplegia in Myopic, Hyperopic and Emmetropic Eyes.

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DisclosureBlock: Yuval Cohen, None; Ahmed Sindawi, None; Aviv Vidan, None; Otzem Chassid, None;

Purpose
Prescribing glasses for children is usually determined through examining both dry and cycloplegic refraction, those refractions might vary greatly. We sought to examine refraction and ocular biometry using IOLMaster 700 before and after cycloplegia of pediatric myopes, hyperopes, and emmetropes.

Methods
Children age 5-11 years (N-64) were categorized into three refraction groups, Myopes, hyperopes and emmetropes. Refraction keratometry and biometric measurements were taken before, and 40 min after drops of cyclopentolate 1% and tropicamide 1%. The ANOVA tests was used to compare the effects of cycloplegia between the groups.

Results
Spherical equivalent before cycloplegia were -3.77, +3.57 and +0.24 diopters(D), and changed to -1.68, +5.12, and 0.9 D during cycloplegia for the Myopes, hyperopes and emmetropes, respectively. During cycloplegia, comparable changes in axial length, anterior chamber depth, and lens thickness were measured between the groups.

Conclusions
Cycloplegia induces a significant hyperopic shift and biometric changes that are independent of refraction.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Correlation Analysis of Refraction and Biometric Parameters in Chinese Schoolchildren

AuthorBlock: Ruiyang Li, Yahan Yang, Pisong Yan, Wenben Chen, Xiaohang Wu, Lanqin Zhao, Xiyong Dong, Yi Zhu, Chuan Chen, Jialing Huang, Haotian Lin

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DisclosureBlock: Ruiyang Li, None; Yahan Yang, None; Pisong Yan, None; Wenben Chen, None; Xiaohang Wu, None; Lanqin Zhao, None; Xiyong Dong, None; Yi Zhu, None; Chuan Chen, None; Jialing Huang, None; Haotian Lin, None;

Purpose
To evaluate the association between the degree of refraction and biometric parameters and identify the effective parameters for refractive development.

Methods
A total of 1094 schoolchildren aged 6 to 15 years, the peak stage of myopia development, from southern China were included in this study. Biometric parameters, including refraction in diopters, central corneal thickness (CCT), anterior-chamber depth (ACD), pupil distance (PD), mean corneal curvature (CC), and high order aberrations (HOAs) with Zernike coefficients were obtained via an autorefractor. Height and weight of children were measured according to standard methods. Spherical equivalent refraction (SER) and body mass index (BMI) were calculated. Gradient Boosting regression analysis was performed to evaluate the correlations between SER and the other biometric parameters (CCT, ACD, PD, CC, HOAs, and BMI). The 3-fold cross-validation was applied to assessed robustness of models. In addition, model-based feature selection was utilized to identify the most effective parameters for refractive development.

Results
Among these 1094 schoolchildren aged between 6 to 15 years old with successful ocular biometric measurements, mild and moderate myopia (as defined by clinical standards) were the dominant refractive errors in 75.07% of the sample population. Of these, 405 participants completing physical examination were included in the BMI analysis. The regression model based on ocular parameters showed that SER predicted by CCT, ACD, PD, CC, and HOAs was significant correlated with true SER status (the mean Pearson correlation coefficient R=0.30, p<0.001). In the regression model based on both ocular parameters and BMI, the predicted SER was also significant associated with the true SER (the mean Pearson correlation coefficient R=0.28, p<0.001). The feature selection showed that PD, BMI, HOAs with Zernike coefficients, and mean CC were the most effective parameters for SER development.

Conclusions
In our study, Chinese schoolchildren aged 6-15 years were predominantly mildly and moderately myopic. Biometric parameters (CCT, ACD, PD, CC, HOAs, and BMI) were the contributors to the SER development. Of these parameters, PD, BMI, HOAs, and CC were the strong effective parameters for refractive development, which was valuable for understanding the mechanism of rapid progression of myopia in schoolchildren.

Layman Abstract (optional): Provide a 50-200 word description of your work that non-scientists can understand. Describe the big picture and the implications of your findings, not the study itself and the associated details.
Figure 1: Regression model performance

Figure 2: Effective parameters for SFR development

FD—pupil distance, BMI—body mass index, CC—corneal curvature