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Five-year changes in anterior segment parameters in an older population in urban southern China: the Liwan Eye Study

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ABSTRACT

Purpose To investigate the 5-year changes in static and dynamic anterior segment optical coherence tomography (AS-OCT) parameters and their predictors.

Methods This was a prospective, population-based cohort study of people aged 50 years and older residing in the Liwan District, Guangzhou, China. Standardised AS-OCT scans were performed in November 2008 and November 2013 under dark and light conditions. Customised software was used to analyse horizontal AS-OCT images. Parameters in dark and measurements of light-to-dark changes were used for analyses.

Results A total of 186 (71.8%) subjects underwent AS-OCT twice, 5 years apart and were included for analyses. The mean age in 2008 was 64.7±7.0 years, and 60.2% were women. The anterior chamber width (ACW) decreased from 11.74±0.44 mm in 2008 to 11.60±0.37 mm in 2013 (p=0.001). There was a trend towards a decrease in dynamic capacity (light-to-dark changes) in the anterior segment, with decreased iris thickness at 750 µm (ΔIT750), ΔACW, Δ anterior chamber area (ACA) and Δ pupil diameter at 5 years (all p<0.05). After adjusting for age and sex, the following baseline parameters were associated with a greater decrease rate in trabecular iris space area at 500 µm (TISA500) at 5 years: TISA500, IT750 and ACA in dark (p<0.001 for all).

Conclusions Anterior chamber angle width decreased and the amount of light-to-dark changes declined during 5-year follow-up. Subjects with greater height, wider angle width and thicker iris at baseline have greater angle narrowing at follow-up.

INTRODUCTION

Primary angle-closure glaucoma (PACG) is a leading cause of irreversible blindness, affecting 20.17 million people worldwide, 76.7% of whom are of Asian ethnicity.[1] The number of people with PACG is expected to increase to 23.36 million in 2020 and 32.04 million in 2040 globally.[1] Ocular biometric features such as a shallower anterior chamber, smaller central corneal diameter, a thicker and more anterior placed lens and shorter axial length have been identified as important risk factors for PACG.[2] Population-based studies have also shown that women and those of Chinese descent have a higher risk of developing PACG.[3 4]

The introduction of anterior segment optical coherence tomography (AS-OCT) has expanded our understanding of biometric risk factors for PACG. This technique permits the capture of the entire anterior segment in a single image and provides repeatable and quantitative measurements of the anterior segment parameters with excellent accuracy.[5] Cross-sectional studies using AS-OCT identified novel risk factors for angle closure, such as shorter anterior chamber width (ACW), smaller anterior chamber area (ACA), thicker iris with greater curvature and area, and greater lens vault (LV).[6–9] Dynamic AS-OCT parameters such as increase in iris volume changes with physiological or pharmacological dilation were also shown to be strongly associated with PACG in cross-sectional analyses.[10–13]

Information on longitudinal changes in static and dynamic AS-OCT parameters over time is important for predicting future risk of PACG. However, very few cohort studies have produced longitudinal data, most of which was derived from clinics with relative short-term follow-up, small sample sizes and assessment was based on static measures only.[14 15] To the best of our knowledge, there are no population-based studies evaluating the long-term changes in static and dynamic AS-OCT parameters. Therefore, the aim of this study was to assess the 5-year changes of AS-OCT parameters in dark and light-to-dark conditions in a cohort of older Chinese people, using data obtained from follow-up visits in the population-based Liwan Eye Study.

METHODS

Statement of ethics

The study was approved by the Ethical Review Board of the Zhongshan Ophthalmic Centre, and the Research Governance Committee of Moorfield's Eye Hospital. The study adhered to the tenets of the Helsinki Declaration. Written informed consent was obtained from all subjects.

Study participants

The Liwan Eye study was a population-based cohort study, its methodology and details have been described previously.[16 17] In brief, the Liwan district of Guangzhou was selected for the survey because of its relatively stable population and representative demographic and socioeconomic characteristics. Chinese persons aged 50 years and older were identified by cluster random sampling and were invited for a comprehensive eye examination in a research clinic set up nearby communities. The baseline eye examination was performed between September

2003 and February 2004, the 5-year and 10-year follow-up examinations were performed in November 2008 and November in 2013, respectively. At the 5-year and 10-year follow-up, one out of two subjects were systematically selected to undergo AS-OCT imaging under dark and light conditions as well as detailed ocular examinations. All examination equipment was the same at baseline and at follow-up. The same instrument (AS-OCT device) and image capture protocol were used at baseline and follow-up. In the current study, AS-OCT imaging data at 5-year and 10-year follow-up were analysed. Subjects at baseline and follow-up were excluded if they were aphakic/pseudo-phakic or had a history of intraocular surgery, laser therapy, ocular trauma and corneal disease that may affect AS-OCT imaging.

Biometric examinations

All subjects underwent a standardised interview and comprehensive examinations. Height was measured in centimetres using a wall-mounted measuring tape. Weight was measured in kilograms with a digital scale. Lens thickness (LT), axial length (AL), and central anterior chamber depth (ACD) were measured by A-scan ultrasound sonography (Model US-800; Nidek Co., Tokyo, Japan). Intraocular pressure was performed using a hand-held tonometer (Tonopen; Mentor, Norwell, MA, USA) device after instilling topical anaesthesia (0.4% Benoxil; Oxybuprocaine, Santen, Japan). Gonioscopy was performed with a Goldmann-type one-mirror lens (Haag Streit, Bern, Switzerland) at ×25 magnification in a dark room. The angle width for four quadrants was graded using the Shaffer method.

AS-OCT imaging and analyses

The standardised protocol for obtaining AS-OCT images has been reported previously.[18–20] AS-OCT (Visante; Carl Zeiss Meditec, Dublin, CA, USA) imaging was performed under dark lighting conditions (<5 lux, to induce physiological mydriasis) and then under light conditions (350–400 lux) using a standardised light source. The single-scan protocol which produces 256 scans in 0.125 s was used to obtain AS-OCT images. Refractive correction was used to adjust the internal fixation target to prevent accommodation. To ensure scan alignment, the reflex saturation beam was used. The polarisation for each scan was optimised, and the image saturation and noise were adjusted to obtain the best quality image. Each AS-OCT image captured both the temporal and nasal quadrants (nasal-temporal 0°−180°) in a single image. The image with best quality and fewest artefacts was selected for analysis.

A customised version of the Zhongshan Angle Assessment Program (ZAAP, Guangzhou, China) was used to analyse the AS-OCT image measurements. After manually locating the sclera spur, the ZAAP automatically defines the border and curvatures of the anterior segment structures and calculates the AS-OCT parameters. Two experienced and independent graders were masked to the refraction data.

The AS-OCT parameters obtained by ZAAP has been shown to be highly reproducible, with an intraclass correlation coefficient exceeding 0.88.[21] Trabecular iris space area at 500 µm (TISA500), angle recess area (ARA), iris thickness at 750 µm (IT750), iris area (Iarea), ACW, ACA, LV and pupil diameter (PD) are illustrated in figure 1. The same lighting conditions, scan protocols and ZAAP software version were used for AS-OCT imaging in 2008 and 2013.

Statistical analysis

Data from right eyes were used for analysis. Light-to-dark changes (Δ) were defined as the measurements of AS-OCT parameters in dark minus light conditions. Continuous variables were presented as mean±SD. Subject demographics and AS-OCT parameters at baseline between the included subjects and excluded subjects were compared with t-test for continuous variables and Fisher's exact test for categorical variables. Included subjects were the patients who finish 5-year follow-up examinations without image problems and previous surgeries. And excluded subjects were the patients lost to follow-up or with image problems and surgeries from 2008 to 2013. The 5-year change of AS-OCT measurements (10-year follow-up minus 5-year follow-up) were assessed using a paired t-test. Associations between longitudinal change rate in TISA500 in dark conditions and potential baseline risk factors were assessed using two mixed-effect models with the assumption that data missing was random, and predictors of missing data were included in the models. Each visit in 2008 and 2013 was assigned a number from 0 to 1 accordingly and was used as a proxy for time. All of the model covariates were adjusted for baseline age and gender. Age, gender, weight, height, systolic blood pressure (SBP), diastolic blood pressure, spherical equivalent (SE), AL, ACD, LT, TISA500, ARA, IT750, larea, ACW, LV, PD, ΔARA, ΔIT750, ΔIarea, ΔACW, ΔACA, ΔLV and ΔPD were included as fixed effects. Individual subject was considered as random effect. Mean changes and 95% CIs were calculated from the mixed models. Model 1 was a univariate regression and model 2 was a multivariate regression. For each variable, the unstandardised regression coefficient (β) and its significance level were obtained. All statistical analysis was performed using Stata SE V.12.0 (Stata Corp, College Station, TX, USA) with a statistical significance set at 0.05.

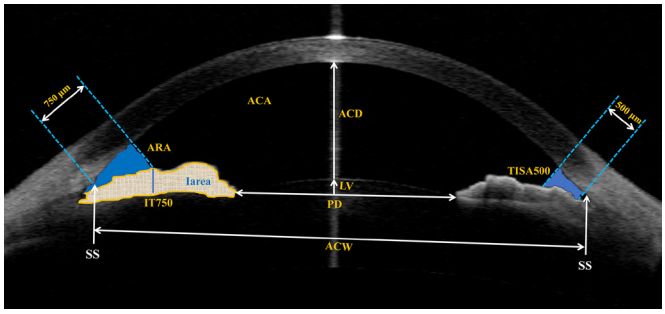

Figure 1 Illustration of AS-OCT measurements of parameters providing by the Zhongshan Angle Assessment Programme. TISA500 is defined as the trapezoidal area with the following boundaries: anteriorly, the angle opening distance 500; posteriorly, a line drawn from the SS perpendicular to the plane of the inner sclera wall to the opposing iris; superiorly, the inner corneoscleral wall; inferiorly, the iris surface. ARA is defined as the area of triangle between anterior iris surface, corneal endothelium, and a line perpendicular to the corneal endothelium drawn to the iris surface 750 µm from the SS. IT750 is the iris thickness at 750 µm from the SS. Iarea is defined as the cumulative cross-sectional area of the full length (from spur to pupil) of the iris. ACW is defined as the horizontal SS to SS distance. ACA is defined as the cross-sectional area of the anterior segment bounded by the endothelium, anterior surface of iris and anterior surface of lens (within the pupil). LV is defined as the perpendicular distance from the horizontal line between the 2 SS to the anterior pole of the lens. PD is the shortest distance between the pupil edges of the iris cross sections. ACA, anterior chamber area; ACW, anterior chamber width; ARA, angle recess area; Iarea, iris area; IT750, iris thickness at 750 µm; LV, lens vault; PD, pupil diameter; SS, sclera spur; TISA500, trabecular iris space area at 500 µm.

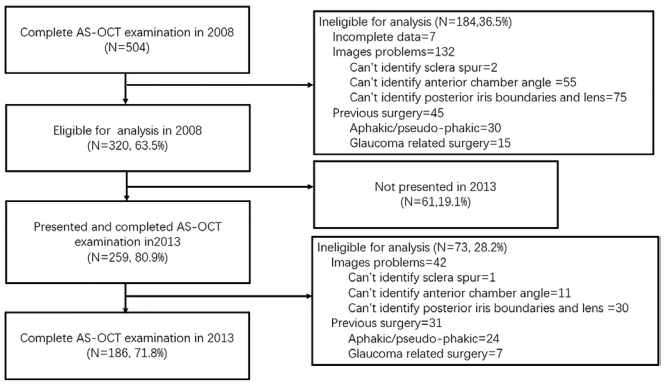

Figure 2 Flow chart of the follow-up of AS-OCT imaging in the Liwan Eye Study. AS-OCT, anterior segment optical coherence tomography.

RESULTS

A total of 504 subjects completed AS-OCT examination in 2008 in both dark and light conditions. Among them, 184 (36.5%) had a history of previous ocular surgery or imaging problems (such as indiscernible scleral spur, inaccurate identification anterior chamber angle, inaccurate identification posterior iris boundaries and lens) that precluded accurate measurement of AS-OCT parameters and were excluded from analysis. The remaining 320 (63.5%) eligible subjects had available data for analyses from 2008. Of those subjects, 259 (80.9%) presented in 2013, 73 (28.2%) of whom were ineligible because of the ocular surgery during the follow-up period or imaging problems. Finally, a total of 186 (71.8%) subjects were included in the final statistical analyses. The flowchart of participants selection is shown in figure 2.

Baseline characteristics of eligible participants included in and excluded from analysis are shown in table 1. Included subjects tended to be significantly younger (p<0.001), with lower SBP (p=0.023), greater ACA (p=0.004), smaller LV (p=0.008) and larger PD (p=0.009) in dark, but there were no significant differences in other demographic and ocular biometric parameters in comparison with the subjects who were not included in the analysis. The mean age of analysed subjects was 64.7±7.0 years, and 60.2% were women.

The 5-year changes of AS-OCT parameters in dark and light-to-dark during follow-up are shown in table 2. After 5 years, there was a trend towards narrowing of the angle in dark conditions with a significant decrease in ACW (11.74±0.44 mm vs 11.60±0.37 mm, p=0.001) compared with baseline measurements. As respect to light-to-dark changes, the dynamic capacity in angle parameters, iris thickness parameters and LV decreased over time. However, only ΔIT750 (p=0.001), ΔACW (p=0.003) and ΔACA (p<0.001) achieved statistically significance when compared with baseline. A significant decrease in ΔPD (p<0.001) was also observed at follow-up.

To identify potential associated parameters with 5-year change rate in TISA500, univariate and multiple regression analysis models were created. Table 3 shows the association of baseline factors with 5-year change rate of TISA500 in dark conditions. Having a greater height, wider angle and thicker iris at baseline was significantly associated with a greater chance of angle narrowing at follow-up, as TISA500, IT750 and ACA in dark were associated with larger mean TISA500 change rate at follow-up (p<0.001).

Table 1 Baseline (2008) characteristics of eligible participants included in and excluded from analysis

Variable	Respondents	Non-respondents	P value
Demographic			
No. of subjects	186	134	**<0.001**
Age, year	64.7±7.0	69.4±7.9	**<0.001**
Gender (M/F)	74/112	45/89	0.257*
Weight, kg	56.4±9.0	56.3±10.5	0.973
Height, cm	155.9±8.2	154.8±8.7	0.224
SBP, mm Hg	135.0±21.8	140.7±21.7	**0.023**
DBP, mm Hg	72.3±12.8	71.9±12.3	0.767
SE, dioptre	1.1±2.5	1.6±2.2	0.066
Biometric parameter			
AL, mm	23.8±5.7	24.8±11.5	0.287
ACD, mm	2.8±0.5	2.8±1.0	0.644
LT, mm	5.8±9.8	7.0±14.2	0.403
IOP, mm Hg	14.1±2.8	13.6±3.0	0.128
TISA500, mm^2	0.077±0.05	0.078±0.05	0.919
ARA750, mm	0.158±0.10	0.156±0.09	0.846
IT750, mm	0.450±0.18	0.455±0.18	0.812
Iarea, mm^2	1.569±0.48	1.591±0.29	0.631
ACW, mm	11.74±0.44	11.66±0.47	0.089
ACA, mm^2	18.94±2.89	17.93±3.34	**0.004**
LV, µm	573.5±246.2	651.4±278.7	**0.008**
PD, mm	4.319±1.14	3.97±1.23	**0.009**
ΔTISA500, mm^2	0.218±0.032	0.020±0.029	0.514
ΔARA, mm^2	0.045±0.065	0.041±0.054	0.516
ΔIT750, mm	−0.755±0.166	−0.632±0.162	0.509
ΔIarea, mm^2	0.271±0.415	0.256±0.267	0.731
ΔACW, mm	0.052±0.197	0.024±0.160	0.178
ΔACA, mm^2	−0.707±0.271	−0.644±0.304	0.057
ΔLV, µm	20.4±70.9	11.7±63.3	0.259
ΔPD, mm	−1.678±1.112	−1.241±1.210	**0.001**

Bold indicates statistical significance.
*Fisher exact probability test.
Δ, light-to-dark changes (dark minus light); ACA, anterior chamber area; ACD, anterior chamber depth; ACW, anterior chamber width; AL, axial length; ARA, angle recess area;BP, blood pressure;DBP, diastolic blood pressure; IOP, intraocular pressure; IT750, iris thickness at 750 µm; Iarea, iris area; LT, lens thickness; LV, lens vault; PD, pupil diameter; SBP, systolic blood pressure; SE, spherical equivalent; TISA500, trabecular iris space area at 500 µm.

DISCUSSION

This is the population-based cohort study investigating the long-term changes in AS-OCT parameters in both dark and light-to-dark conditions. The results demonstrated a significant decrease in angle width and decrease in dynamic capacity (light-to-dark changes) over time. The level of anterior chamber narrowing over time was predicted by greater height, angle depth and thicker iris parameters in dark conditions at baseline.

The current study confirms the findings from cross-sectional studies which have previously reported that angle parameters slope negatively with age, with −0.0119 mm/year for ACD, −0.0845 mm^2/year for Iarea; while iris parameters and LV had positive slopes with age, with 0.0084 mm/year for LV, 0.0019 mm/year for Icurv, 0.0006 mm/year for IT750, 0.0008 mm/year for IT500, 0.0131 mm^2/year for Iarea.[22] In another clinical-based studies, negative age-related changes of AS-OCT parameters were observed, and the normalised slopes of ACD, angle opening distance (AOD)500, ARA, TISA500 were −0.02396 mm/year,

Table 2 Five-year changes of AS-OCT parameters in dark and light-to-dark during the follow-up

Parameter	Baseline measurement	Follow-up measurement	Mean difference (95% CI)*	P value
In dark condition				
TISA500, mm^2	0.077±0.05	0.082±0.05	−0.005 (-0.015 to 0.004)	0.287
ARA750, mm^2	0.158±0.101	0.164±0.091	−0.006 (−0.026 to −0.013)	0.548
IT750, mm	0.450±0.176	0.473±0.897	−0.023 (−0.05 to −0.006)	0.119
Iarea, mm^2	1.569±0.484	1.537±0.226	0.031 (−0.046 to −0.108)	0.431
ACW, mm	11.74±0.44	11.60±0.37	0.141 (0.058 to 0.224)	**0.001**
ACA, mm^2	18.94±2.89	18.51±2.94	0.426 (−0.168 to 1.020)	0.160
LV,µm	573.5±246.2	551.7±266.7	21.772 (−30.56 to 74.11)	0.414
PD, mm	4.32±1.14	4.44±0.69	−0.124 (−0.315 to 0.068)	0.205
Light-to-dark changes				
ΔTISA500, mm^2	0.022±0.032	0.023±0.031	−0.001 (−0.007 to 0.006)	0.822
ΔARA, mm^2	−0.045±0.065	−0.049±0.067	−0.004 (−0.017 to 0.009)	0.521
ΔIT750, mm	−0.075±0.166	−0.032±0.081	−0.044 (−0.070 to −0.167)	**0.001**
ΔIarea, mm^2	0.270±0.414	0.262±0.183	0.009 (−0.056 to 0.075)	0.784
ΔACW, mm	0.052±0.197	−0.006±0.166	0.057 (0.020 to 0.094)	**0.003**
ΔACA, mm^2	−0.709±0.271	−0.589±0.273	−0.118 (−0.174 to -0.062)	**<0.001**
ΔLV, µm	20.4±70.9	15.996±75.96	4.4 (−10.5 to 19.3)	0.564
ΔPD, mm	−1.7±1.1	−1.3±0.9	−0.42 (−0.63 to -0.22)	**<0.001**

Bold indicates statistical significance.
*Parameters in 2008 minus those in 2013.
ACA, anterior chamber area; ACW, anterior chamber width; ARA, angle recess area;AS-OCT, anterior segment optical coherence tomography; IT750, iris thickness at 750 µm; Iarea, iris area; LV, lens vault; PD, pupil diameter; TISA500, trabecular iris space area at 500 µm.

−0.00634 mm/year, −0.0019 mm^2 /year, −0.00177 mm^2 /year, respectively.[23]

The findings of the current study suggest that angle narrowing occurs over time and is consistent with previous longitudinal studies. These findings could partly explain the phenomenon that older people have narrower angles and prevalence of PACG increases with ageing suggested in previous literature.[17] A study of Chinese participants aged ≥35 years found that AOD500 decreased from 0.25±0.13 mm at baseline to 0.21±13 mm at 2-year follow-up and ARA decreased from 21.5±3.73 to 21.0±3.64 mm^2; however, no significant changes in LV or ACW were noted during the 2-year follow-up.[24] In a community-based cohort of Singaporean adults with open angles, He *et al*[14] found a significant decrease in angle and anterior chamber parameters. However, the IT2000 and Iarea in nasal and temporal quadrants decreased significantly during the 4-year follow-up. Interestingly, our observed 5-year decrease in TISA500 (6.5% of the baseline values) was smaller than that reported in previous studies. These differences may be caused by different population characteristics, a narrower baseline angle and older age in the present cohort. The relatively small rate of narrowing of angle width was also observed in the eyes of primary angle-closure suspects (PACS).[5]

The lens probably moves anteriorly (estimated by LV) through the effect of cataract formation occupying the space in anterior chamber with age increasing. The effect of iris and lens interaction make the iris forward changing the iris volume and increasing pupillary block. Several clinic-based studies have demonstrated that the decrease in iris volume after pupil dilation was less in patients with PACG than normal patients or those with primary open-angle glaucoma (POAG).[25–27] A population-based cross-sectional study of rural Chinese persons has shown that the decrease in Iarea and iris volume after physiological and pharmacological dilation was significantly less in PACS than normal eyes.[12, 13] Additionally, Seager *et al*[28] found that Iarea was related to age, race, disease diagnosis and Iarea loss per millimetre of pupil dilation. The association between loss of Iarea on dilation, race and age has also been found to exist in Korean patients with PAC or POAG and was found to decline with age.[29] Similarly, our study confirmed results above and suggested that dynamic AS-OCT parameters declined over time, which was corresponded with the higher prevalence of PACG in older persons. However, the longitudinal changes of dynamic AS-OCT parameters require further study.

The TISA500 has been described as an indicator of angle area because it is a more objective measure than the point distance (AOD500).[30] The finding that the height was correlated with the narrowing of TISA500 was in accord with our previous analysis in this population that shorter height was significantly associated with narrower angle width ($p<0.001$).[29] Eyes with a wider angle at baseline had a greater chance rate of TISA500 narrowing at follow-up in this cohort, which may be due to a ceiling effect. Similar findings were observed in our previous 2-year cohort study with younger subjects. Those who had a larger baseline AOD500 showed a greater decrease in AOD500 and ARA at follow-up.[24] The decrease in ACD was shown to be associated with deeper baseline ACD and greater ACA. In a community-based study of 204 Singaporeans, the 4-year decrease in TISA750 was reported to be lower in eyes with shorter AL and greater Icurv at baseline.[14] However, our study did not detect this correlation and this may be related to different population characteristics and study design.

We find that light-to-dark change of angle and iris parameters are not associated with angle narrowing. And in multivariate analysis, greater height, wider angle and thicker iris at baseline were the only independent factors associated with changes rate in TISA500 at follow-up. These findings may shed light on our understanding of the risk factors for PACG in the Chinese population. Meanwhile, it has implications in understanding the evolution of anterior segment changes in eyes with angle closure.

There are several advantages of this study; these include the population-based study design which minimises selection bias

Table 3 Association of baseline factors with 5-year change rate of TISA500 in dark condition

Baseline variable	Model 1 coefficient (95% CI)	P value	Model 2 coefficient (95% CI)*	P value
Age, year	0.0226 (−0.0139 to 0.059)	0.225	0.0175 (−0.0127 to 0.0479)	0.256
Gender (M/F)	−0.1572 (−0.523 to 0.209)	0.400	−0.355 (-0.8727 to 0.1626)	0.179
Weight, kg	0.0077 (−0.0104 to 0.0260)	0.404	0.0071 (−0.0130 to 0.0273)	0.488
Height, cm	−0.0085 (−0.0215 to 0.0044)	0.197	−0.0343 (−0.0613 to −0.0081)	**0.005**
SBP, mm Hg	0.00021 (−0.0040 to 0.0044)	0.922	−0.0026 (−0.0134 to 0.00610)	0.467
DBP, mm Hg	−0.0038 (−0.0151 to 0.0074)	0.499	−0.0016 (−0.0171 to 0.0147)	0.811
SE, dioptre	−0.0133 (−0.0557 to 0.0291)	0.538	−0.0607 (−0.1192 to 0.0158)	0.151
AL, mm	−0.0077 (−0.0127 to -0.0027)	**0.003**	0.0218 (−0.0739 to 0.1230)	0.634
ACD, mm	−0.0124 (−0.3141 to 0.2893)	0.936	−0.2211 (−1.234 to 0.7863)	0.688
LT, mm	−0.0059 (−0.0089 to −0.0028)	**0.011**	0.0090 (−0.0111 to 0.0296)	0.120
TISA500, mm^2	−6.2306 (−11.0521 to −1.4090)	**<0.001**	−26.838 (−47.262 to −20.203)	**0.008**
ARA, mm^2	−2.3040 (−3.9662 to −0.6419)	**0.007**	6.7115 (−3.6145 to 16.380)	0.066
IT750, mm	−0.4571 (−1.3943 to 0.4801)	0.339	−3.1758 (−4.989 to 0.5221)	**0.003**
Iarea, mm^2	0.1688 (−0.1140 to 0.3451)	0.067	0.7658 (−0.3135 to 1.6066)	0.094
ACW, mm	0.7760 (0.2823 to 1.2697)	**0.002**	0.0221 (−0.5721 to 0.7389)	0.931
ACA, mm^2	0.0447 (−0.0312 to 0.1206)	0.249	0.1318 (0.0113 to 0.2838)	**0.023**
LV, µm	0.0002 (−0.0004 to 0.0009)	0.455	0.0001 (−0.00101 to 0.0012)	0.786
PD, mm	−0.0768 (−0.2502 to 0.0966)	0.386	0.0304 (−0.3108 to 0.3339)	0.847
ΔARA, mm^2	1.3023 (−0.0599 to 2.6646)	0.061	−2.1270 (−30.0325 to −3.8854)	0.272
ΔIT750, mm^2	0.1777 (−0.4321 to 0.7876)	0.568	−0.9749 (−1.302 to 11.9384)	0.266
ΔIarea, mm^2	−0.1074 (−0.2874 to 0.0727)	0.243	0.1311 (−0.66559 to 1.2264)	0.753
ΔACW, mm	−0.9413 (−1.6071 to −0.2755)	**0.006**	−0.2284 (−1.236 to 1.10341)	0.643
ΔACA, mm^2	0.4067 (−0.3564 to 1.169)	0.296	0.4083 (−0.1823 to 0.018)	0.232
ΔLV,µm	−0.0032 (−0.0060 to 0.0004)	**0.027**	−0.0024 (−0.0060 to −0.0015)	0.224
ΔPD, mm	0.0888 (−0.0753 to 0.2731)	0.266	0.0783 (−0.2378 to 0.4040)	0.662

TISA500 change was defined as TISA500 in 2013 minus TISA500 in 2008.
Model 1 is a univariate regression analysis; model 2 is a multiple regression analysis.
Bold indicates statistical significance.
*Adjusted for age, gender, weight, height, SBP, DBP, SE, AL, ACD, LT, TISA500, ARA, IT750, Iarea, ACW, LV, PD, ΔARA, ΔIT750, ΔIarea, ΔACW, ΔACA, ΔLV, ΔPD.
Δ, light-to-dark changes (dark minus light); ACA, anterior chamber area; ACD, anterior chamber depth; ACW, anterior chamber width; AL, axial length; ARA, angle recess area; DBP, diastolic blood pressure; ΔIT750, iris thickness at 750 µm; Iarea, iris area; LT, lens thickness; LV, lens vault; PD, pupil diameter; SBP, systolic blood pressure; SE, spherical equivalent; TISA500, trabecular iris space area at 500 µm.

and the analysis of both static and dynamic AS-OCT parameters which were not collected in previous studies. And mixed-effect model was used to assess the change-to-change relationships after controlling for confounding factors.

Nevertheless, there are several limitations that warrant further consideration. First, only 186 (71.8%) subjects with complete data were included in the longitudinal analysis. However, this is similar to the 61% of participants with eligible images at both baseline and follow-up in the previous cohort study of Singaporean participants by He *et al*[14] The limitations of time-domain OCT in terms of poor axial resolution and motion artefacts. Reasons for the high percentage of image problems may be related to three primary reasons (cannot identify scleral spur, cannot identify anterior chamber angle, cannot identify posterior iris boundaries and lens). The fact that a comparison of longitudinal changes requires image quality to be acceptable at both baseline and follow-up visits. Second, stratifying analyses by age, sex or quartile of baseline angle parameters is not possible due to the relatively small sample size. Further cohort study with larger sample size are warrant to confirm our findings. Third, a single scan was used to measure AS-OCT parameters, regional variations of anterior chamber and iris structure may exist, and further studies are warranted. Finally, the findings may not be generalisable to other populations. Comparisons of static and dynamic changes in anterior segment structure between Chinese and Caucasian subjects have shown that Chinese have greater iris parameters and lower dynamic changes in AS-OCT parameters than Caucasians. Therefore, further research is required in other ethnic backgrounds to confirm these findings.

CONCLUSIONS

In conclusion, there was a significant decrease in angle parameters and a decline in light-to-dark changes during the 5-year follow-up in this population-based sample of Chinese subjects. The level of anterior chamber narrowing was associated with height, angle and iris parameters in dark conditions at baseline. Further studies are warranted to clarify the underlying mechanisms of these changes in anterior segment parameters.

Correction notice This paper has been corrected since it was published online. The project name,Fundamental Research Funds of the State Key Laboratory in Ophthalmology was missing from the funding statement and this has now been added.

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