Myopia in Asian Subjects with Primary Angle Closure

Implications for Glaucoma Trends in East Asia

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Purpose: To evaluate the occurrence of myopia in Asian subjects with angle closure and to assess the ocular biometric parameters in these subjects.

Design: Cross-sectional study.

Participants: We prospectively recruited 427 angle-closure subjects (143 primary angle-closure suspects, 75 patients with primary angle closure, 165 patients with primary angle-closure glaucoma, and 44 patients with acute primary angle closure) from a Singapore hospital.

Methods: Refractive status was derived from the spherical equivalent of autorefraction. A-scan biometry (Nidek Echoscan Ultrasound US-800; Nidek Co., Tokyo, Japan) was performed to obtain anterior chamber depth (ACD), axial length (AL), lens thickness, and vitreous cavity length (VL). Anterior segment optical coherence tomography was performed to measure lens vault.

Main Outcome Measures: Refractive status was categorized as myopia (≤ -0.50 diopter [D]), emmetropia (-0.50 to $+0.50$ D), and hyperopia ($\geq +0.50$ D).

Results: The mean age ± standard deviation of study subjects was 65.6±7.6 years, with most being Chinese (n = 394; 92.3%) and women (n = 275; 64.4%). Overall, myopia was present in 94 subjects (22%), hyperopia was present in 222 subjects (52%), and emmetropia was present in 111 subjects (26%). Of the 94 myopic angle-closure patients, 28 (29.8%) were categorized as having moderate myopia (≤ -2.0 to -5.0D) and 11 (11.7%) were categorized as having high myopia (≤ -5.00 D). Although myopic angle-closure subjects had longer ALs ($P<0.001$) and VLs ($P = 0.001$) than their emmetropic and hyperopic counterparts, there were no significant differences in ACD ($P = 0.77$), lens thickness ($P = 0.44$), or lens vault ($P = 0.053$).

Conclusions: Almost one quarter of angle-closure patients were myopic. Myopic angle-closure subjects had longer VLs and ALs, but there was no difference in ACD. With the increasing rate of myopia in many East Asian populations, there may be many subjects with axial myopia but shallow ACD and angle closure. The implication is that ophthalmologists should not assume that glaucoma patients who are myopic have open angles. *Ophthalmology 2014;■:1–6 © 2014 by the American Academy of Ophthalmology.*

Established biometric risk factors for primary angle-closure glaucoma (PACG) include hyperopia, a short axial length (AL), shallow anterior chamber depth (ACD), and increased lens thickness.[1–5] Of these, a shallow ACD is considered a cardinal risk factor for angle closure, and it is believed that hyperopic subjects have shorter ALs and shallower ACDs, which predispose them to having angle closure.[6,7]

Recent studies have described the presence of myopia in primary angle-closure patients.[8,9] Chakravarti and Spaeth[8] reported that 6 (1.9%) of 322 angle-closure patients had high myopia, whereas Barkana et al[9] showed that only 9 (0.05%) of 17 938 patients with high myopia (≤ -6.0 diopters [D]) had primary angle closure (PAC). However, these studies did not investigate the possible mechanism(s) for angle closure developing in such myopic patients.

With the increasing prevalence of myopia in Asia,[10–12] one would expect a commensurate reduction in the prevalence of PACG, because myopia is considered to be a protective factor against PACG. However, in our practice, we have noted that there is a significant and increasing number of angle-closure patients with myopia. We hypothesize that although the mean AL and vitreous cavity length (VL) are longer in myopic angle-closure patients compared with those who are hyperopic, the ACD may be similarly shallow.

The aim of this study was to evaluate the occurrence of myopia in Asian subjects with angle closure and to assess ocular biometric parameters in these subjects. The biometric features of the angle-closure patients with high myopia also were evaluated.

Methods

Our study recruited 427 angle-closure patients attending glaucoma clinics at the Singapore National Eye Centre. These included patients categorized as primary angle-closure suspects (PACS), those with PAC, those with PACG, or those with previous acute primary angle closure (APAC).[13] Written informed consent was obtained

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Table 1. Demographic Features of the Study Population

	Primary Angle-Closure Suspects (n = 143)	Primary Angle-Closure (n = 75)	Primary Angle-Closure Glaucoma Group (n = 165)	Previous Acute Primary Angle-Closure (n = 44)	P Value	Overall (n = 427)
Subgroup proportion (%)	33.5	17.6	38.6	10.3		100
Mean age (SD), yrs	63.1 (7.6)	66.0 (8.1)	68.4 (9.4)	62.2 (7.9)	<0.001†	65.6 (8.8)
Ethnicity						
Chinese	135 (94.4%)	66 (88.0%)	151 (91.5%)	42 (95.5%)	0.323	394 (92.3%)
Non-Chinese*	8 (5.6%)	9 (12.0%)	14 (8.5%)	2 (4.5%)		33 (7.7%)
Gender						
Male	38 (26.6%)	28 (37.3%)	73 (44.2%)	13 (29.5%)	0.010‡	152 (35.6%)
Female	105 (73.4%)	47 (62.7%)	92 (55.8%)	31 (70.5%)		275 (64.4%)

APAC = previous acute primary angle closure; PACG = primary angle-closure glaucoma; PACS = primary angle-closure suspects; SD = standard deviation.
*Non-Chinese ethnicity includes Malays, Indians, Sikhs, Eurasians, Burmese, and Filipinos.
†Significant pairwise comparisons: $P<0.001$ for PACS vs. PACG, $P<0.001$ for PACG vs. APAC (1-way analysis of variance).
‡Significant pairwise comparisons: $P = 0.002$ for PACS vs. PACG (chi-square test).

from all subjects, and ethics approval was obtained from the institutional review board of the hospital. The study was carried out in accordance with the tenets of World Medical Association's Declaration of Helsinki.

In brief, PACS was defined as an eye with narrow angles (in which the pigmented posterior trabecular meshwork was not visible on gonioscopy for at least 180° in the primary position) and intraocular pressure (IOP) of 21 mmHg or less in the absence of glaucomatous optic neuropathy or peripheral anterior synechiae. Primary angle closure was defined as the presence of narrow angles with peripheral anterior synechiae, raised IOP of more than 21 mmHg, or both, but without glaucomatous optic neuropathy. Primary angle-closure glaucoma was defined as eyes with PAC associated with glaucomatous optic neuropathy (defined as loss of neuroretinal rim with a vertical cup-to-disc ratio of >0.7 or an intereye asymmetry of 0.2, notching attributable to glaucoma, or both). Previous APAC was defined if the subject had an episode with the presence of at least 2 of the following symptoms: ocular or periocular pain, nausea or vomiting, or both and an antecedent history of intermittent blurring of vision with haloes; a presenting IOP of more than 28 mmHg; and the presence of at least 3 of the following signs: conjunctival injection, corneal epithelial edema, mid-dilated unreactive pupil, and shallow anterior chamber. Patients with secondary glaucoma, such as neovascular and uveitic glaucoma, and patients with previous ocular surgeries or laser iridoplasties were excluded. Laser peripheral iridotomy was performed previously for all subjects.

All subjects underwent a standardized eye examination that included visual acuity measurement using a logarithm of minimum angle of resolution chart (Lighthouse, Inc, Long Island, New York), slit-lamp examination (Model BQ 900; Haag-Streit, Bern, Switzerland), stereoscopic optic disc examination with a 78-D lens (Volk Optical, Inc, Mentor, OH), automated refraction and keratometry (Canon RK 5 Auto Ref-Keratometer; Canon, Inc, Ltd, Tochigiken, Japan), and IOP measurement with Goldmann applanation tonometry (Haag-Streit, Koniz, Switzerland). Gonioscopy was performed in the dark using a Goldmann 2-mirror lens at high magnification (×16). Indentation gonioscopy with a Sussman 4-mirror lens (Ocular Instruments, Inc, Bellevue, WA) was used to establish the presence or absence of peripheral anterior synechiae.

Refractive status was derived from the spherical equivalent of the subject's average autorefraction. Refractive status was categorized as myopia (≤−0.50 D), emmetropia (−0.50 to +0.50 D), and hyperopia (≥+0.50 D). Central ACD, AL, and lens thickness were measured by A-scan biometry (Nidek Echoscan Ultrasound US-800; Nidek Co, Ltd, Tokyo, Japan). These results were used to calculate vitreous cavity length (VL, calculated as: VL = AL−ACD−lens thickness) and relative lens position (calculated as: [ACD+0.5 lens thickness]/AL). Relative lens position was analyzed to rule out subclinical subluxated lens.

Anterior segment optical coherence tomography (Visante; Carl Zeiss Meditec, Dublin, CA) imaging was performed under dark room conditions (0 lux). Scans were centered on the pupil and were obtained along the horizontal axis (nasal−temporal angles at 0° to 180°) using the standard anterior segment single-scan protocol. The images were processed using customized software, the Zhongshan Angle Assessment Program (ZAAP, Guangzhou, China),[14] by a single observer (M.E.N.) who was masked to clinical data. The locations of the 2 scleral spurs were determined by the observer and the algorithm then automatically calculated the lens vault, defined as the perpendicular distance between the anterior pole of the crystalline lens and the horizontal line joining the 2 scleral spurs.

Statistical analysis was performed using R software (The R Foundation for Statistical Computing, Vienna, Austria). Differences in mean values of parametric data among eyes of different subjects were examined using a 1-way analysis of variance. The null hypothesis was rejected at the 0.05 significance level. If the differences among the groups were significant, a pairwise t test with Bonferroni adjustment was used to ascertain which pair of groups had a significant difference.

Results

We recruited 427 subjects, which included 143 PACS, 75 with PAC, 165 with PACG, and 44 with previous APAC. Most were of Chinese ethnicity (n = 394; 92.3%), and there were more women (n = 275; 64.4%). The subjects' ages ranged from 41 to 93 years, and the mean age was 65.6 years (standard deviation [SD], 8.8 years; Table 1).

The mean spherical equivalent of all subjects was +0.65 D (SD, 2.25 D). Approximately half (52%) of the subjects were hyperopic, with PACS having the highest percentage of hyperopia (70.6%; $P<0.001$). Overall, myopia was present in 94 (22%) of the subjects, with 28 (29.8%) of the myopic angle-closure patients being categorized as having moderate myopia (≤−2.0 to −5.0 D) and 11