• Clinical Research •

Refractive errors and biometry of primary angle-closure disease in a mixed Malaysian population

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Abstract

• AIM: To assess the refractive status, anterior chamber depth (ACD) and axial length (AL) of patients with primary angle-closure disease (PACD).

• METHODS: Retrospective cohort. Data was collected from charts of all PACD patients treated from April 2013 to December 2015. Analysis was done on 137 patient charts with complete biometric data. Patient demographics, PACD type, refractive status (spherical equivalent), ACD and AL were studied.

• RESULTS: The median age of 137 subjects [53 with primary angle-closure suspects (PACS), 27 with primary angle-closure (PAC) and 57 with primary angle-closure glaucoma (PACG)] was 68y (range 21-88y). The majority was Chinese (*n*=68; 49.6%) and most of them were women (*n*=75; 54.7%). The distribution of myopia (*n*=51; 37.2%) and hyperopia (*n*=49; 35.8%) was similar. The ACD was shallower in myopes compared to hyperopes (*P*=0.02) and emmetropia (*P*=0.049) but the AL was not significantly different between groups. There were no patients blind from PACG.

• CONCLUSION: Both myopia and hyperopia can occur in PACD. Despite a shallower ACD in angle closure myopes, the AL was not different between groups.

• KEYWORDS: primary angle-closure suspect; primary angle-closure; primary angle-closure glaucoma; anterior chamber depth; axial length

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INTRODUCTION

Glaucoma has long been recognized as a leading cause of blindness. The scale of this problem will increase with future population growth and increasing life expectancy. The global prevalence of glaucoma for population aged 40-80y is 3.54% and the prevalence of primary angle-closure glaucoma (PACG) is highest in Asia (1.09%)[1]. This number is expected to increase each year.

PACG is responsible for the vast majority of bilateral blindness in East Asia[2-3], Singapore[4] and India [5-7]. The risk factors for PACG include hyperopia, a short axial length (AL), shallow anterior chamber depth (ACD) and increased lens thickness[8-11]. It has been reported that hyperopic subjects have shorter ALs and shallower ACDs, which predispose them to angle-closure[12-13]. Yong *et al*[14] found that amongst Chinese in Singapore, hyperopia (52%) and shallow ACD was seen in half of the patients with angle-closure.

Generally myopia has been shown to be associated with primary open angle glaucoma (POAG)[15-17]. Therefore, with the increasing prevalence of myopia in Asia one would expect an increase in the prevalence of POAG and possibly a reduction in the prevalence of PACG[18-20]. In addition it is also thought that myopia has a protective effect against PACG. However, recent studies have reported the occurrence of myopia in angle closure subjects[14,21]. These studies[21-22] described findings in a homogenous population but little is known of the spectrum of glaucoma cases namely primary angle-closure disease (PACD) in Malaysia which is of mixed ethnicity.

Currently there are not many published data on PACD in Malaysia. Liza-Sharmini *et al* [23-24] found that primary angle-closure (PAC) is not uncommon in Malays and they often present with more advanced disease compared to Chinese. In addition, aggressive disease progression was observed in Malays with the onset of optic neuropathy. However, the study subjects were from different socioeconomic background and this may influence the severity and aggressiveness of the disease.

The aim of this study was to evaluate the refractive status and ocular biometric parameters of subjects with PACD. The occurrence of blindness among these subjects was also assessed.

SUBJECTS AND METHODS

This study is confined to consecutive subjects with PACD seen at a tertiary hospital in Malaysia. Data was collected from records of all patients with angle closure who attended the glaucoma clinic from April 2013 to December 2015. Ethics approval was obtained from the Medical Research and Ethics

Table 1 Demographic features of the study population

Characteristic features	PACS (*n*=53)	PAC (*n*=27)	PACG (*n*=57)	*P*	Total (*n*=137)
Subgroup proportion, %	38.7	19.7	41.6		100
Median age years (min to max)	67 (53 to 83)	70 (21 to 82)	66 (40 to 88)	0.451[a]	68 (21 to 88)
Ethnicity (%)					
Chinese	27 (50.9)	12 (44.4)	29 (50.9)		68 (49.6)
Non-Chinese	26 (49.1)	15 (55.6)	28 (49.1)	0.834[b]	69 (50.4)
Gender (%)					
M	18 (34.0)	13 (48.1)	31 (54.4)		62 (45.3)
F	35 (66.0)	14 (51.9)	26 (45.6)	0.094[b]	75 (54.7)

Statistical test: [a]Kruskal-Wallis; [b]Chi-square.

Committee Malaysia and the study was done in accordance with the tenets of Declaration of Helsinki.

PACD was comprised of patients categorized as primary angle-closure suspects (PACS), PAC and PACG. PACS was defined as an eye with narrow angles, at least 180° iridotrabecular contact (ITC), and an intraocular pressure (IOP) of 21 mm Hg or less in the absence of glaucomatous optic neuropathy (GON) or peripheral anterior synechiae (PAS). PAC was defined as the presence of at least 180° ITC and a raised IOP of more than 21 mm Hg, or PAS, but without glaucomatous optic neuropathy (GON). PACG was defined as eyes with PAC associated with GON and corresponding glaucomatous visual field (VF) defects. GON is defined as a loss of neuroretinal rim with a vertical cup-to-disc ratio of ≥0.7 or an inter-eye asymmetry of ≥0.2, notching attributable to glaucoma, or both. The glaucomatous VF defects are reproducible in at least 2 consecutive VFs, of ≥2 contiguous points with P<0.01 loss or greater, or ≥3 contiguous points with P<0.05 loss or greater on pattern deviation plot, or abnormal Glaucoma Hemifield Test. The extent of blindness, defined as having a best corrected vision of less than 3/60 or an inability to count fingers at 3 m in the better eye, was assessed.

All patients had laser peripheral iridotomy. Key exclusion criteria were: patients with secondary glaucoma such as neovascular and uveitic glaucoma, previous ocular surgeries and records with incomplete data were excluded. If both eyes were eligible, the better eye was selected.

The patient's demographics, visual acuity, refractive status and biometrics were analyzed. The spherical equivalent (SE) was calculated based on the patient's objective refractive status. They were categorized as myopia (<-0.5 D), emmetropia (-0.5 D to +0.5 D) or hyperopia (>+0.5 D). Patients were categorized as having moderate myopia if the SE was ≤-2.0 D to -5.0 D and high myopia if the SE was ≤-5.0 D. The central ACD and AL were obtained from an immersion A-scan biometry (Quantel Medical Compact Touch, USA), which is a non-contact method. This avoids indentation on the cornea and minimizes errors in measuring the AL and ACD.

Table 2 Refractive status of Chinese to non-Chinese *n* (%)

Ethnicity	Myopia	Emmetropia	Hyperopia	Total
Chinese	26 (51.0)	20 (54.1)	22 (44.9)	68
Malay	16 (31.3)	12 (32.4)	16 (32.7)	44
Indian	8 (15.7)	5 (13.5)	9 (18.3)	22
Others	1 (2.0)	0 (0)	2 (4.1)	3
Total (*n*)	51	37	49	137

Statistical analysis was performed using SPSS Version 20.0. Descriptive statistics will be utilized for selected variables. The results will be presented as frequencies and percentage for categorical data. The numerical data which is normally distributed will be presented as mean and standard deviation (SD), while median and range (minimum and maximum) will be presented for numerical data which is not normally distributed. In comparing numerical data which is normally distributed between two groups independent *t*-test will be used in analysis and Mann-Whitney test will be used if the numerical data is not normally distributed. In comparing numerical data which is normally distributed between more than two groups one-way ANOVA test will be used in analysis, while Kruskal-Wallis test will be used if the numerical data is not normally distributed. Pearson's Chi-square test will be used to study association between categorical data, while Fishers exact test will be used if assumptions of Pearson's Chi-square test are not met. The probability values of less than 0.05 (P<0.05) were considered as statistically significant.

RESULTS

A total of 137 charts of patients with complete data were studied. Those with PACD were categorized into 3 subgroups *i.e.* PACS, PAC and PACG. There were 53 with PACS, 27 with PAC and 57 with PACG. Their age ranged from 21-88y, median age was 68y. There were more Chinese (*n*=68; 49.6%) and most were women (*n*=75; 54.7%) (Table 1).

There was a similar distribution of myopia (*n*=51; 37.2%) to hyperopia (*n*=49; 35.8%) with more myopes amongst Chinese (Table 2). Interestingly, there were more hyperopes amongst

Table 3 Refractive status across subgroups

Refractive status	PACS (*n*=53)	PAC (*n*=27)	PACG (*n*=57)	*P*	Overall (*n*=137)
Mean SE (SD)	0.47 (1.86)	-0.86 (1.81)	-0.12 (2.27)	0.023[*c]	-0.04 (+2.08)
Hyperopia (>+0.50 D)					
n (%)	22 (41.5)	5 (18.5)	22 (38.6)		49 (35.8)
Mean, D (SD)	+2.21 (+1.32)	+1.83 (+0.66)	+1.86 (+1.15)	0.585[c]	+2.01 (+1.19)
Emmetropia (+0.50 to -0.50 D)					
n (%)	16 (30.2)	6 (22.2)	15 (26.3)		37 (27.0)
Median (min to max, D)	0.00 (-0.38 to +0.50)	+0.13 (-0.50 to +0.50)	+0.13 (-0.50 to +0.50)	0.896[a]	0.00 (-0.50 to 0.50)
Myopia (<-0.50 D)					
n (%)	15 (28.3)	16 (59.3)	20 (35.1)		51 (37.2)
Median (min to max, D)	-1.75 (-3.00 to -0.63)	-1.75 (-4.50 to -0.73)	-1.81 (-7.40 to -0.62)	0.558[a]	-1.75 (-7.4 to -0.62)

SE: Spherical equivalent. [*]PACS *vs* PAC *P*=0.03; PAC *vs* PACG *P*=0.31; PACS *vs* PACG *P*=0.31. Statistical test: [a]Kruskal-Wallis; [c]One way ANOVA.

Table 4 Refractive status across all groups

Biometry	Hyperopia (*n*=49)	Emmetropia (*n*=37)	Myopia (*n*=51)	*P*
Median SE (min to max, D)	+1.75 (+0.63 to +5.50)	0.00 (-0.50 to +0.50)	-1.75 (-7.40 to -0.62)	
Anterior chamber depth, median (min to max)	2.66 (2.03 to 4.07)	2.64 (2.11 to 3.4)	2.46 (1.85 to 4.2)	0.042[*a]
Axial length				
Mean (SD)	22.73 (0.92)	22.90 (0.92)	22.95 (0.98)	0.481[c]
Range	20.52 to 25.03	20.53 to 24.45	20.42 to 26.38	

[*a]Pairwise comparison myopia *vs* emmetropia *P*=0.049; Myopia *vs* hyperopia *P*=0.022; Emmetropia *vs* hyperopia *P*=0.972. [c]Pairwise comparison myopia *vs* emmetropia *P*=0.972; Myopia *vs* hyperopia *P*=0.507; Emmetropia *vs* hyperopia *P*=0.705. Statistical test: [a]Kruskal Wallis; [c]One way ANOVA.

PACS (41.5%) but more myopes (59.3%) amongst the PAC group. However, in the PACG group there was an almost equal distribution of myopes (35.1%) to hyperopes (38.6%) (Table 3). The ACD was shallower in myopes compared to hyperopes (*P*=0.022) and emmetropia (*P*=0.049). However, there was no difference in AL between groups (Table 4).

Of the 51 myopic angle closure patients in our study, majority had low myopia 34 (66.7%), 14 (27.5%) had moderate (<-2.0 D to -5.0 D) and 3 (5.9.0%) had high (<-5.0 D) myopia.

DISCUSSION

In our study on PACD, majority were women (54.7%) with a preponderance of Chinese (49.6%). This is similarly seen in a study by Yong *et al*[14], where 64% of 427 angle-closure patients were mostly women and majority were Chinese (92.3%). This may be attributed to the underlying racial distribution of Singapore where Chinese make up 76.1% of the resident population[25]. In Malaysia, 68.8% of the population comprise of Malays and other Bumiputera groups, followed by Chinese 23.2%, Indians 7.0% and other ethnic groups 1%[26]. However, despite this differing pattern of racial distribution in Malaysia, the ratio of Chinese to non-Chinese with PACD *i.e.* PACS, PAC and PACG, was similar. This may be explained by the high prevalence of angle-closure found in Chinese[9,27-28]. The study also showed that 22% of 427 angle-closure subjects had myopia but hyperopes was still prevalent amongst PACS and PACG[14]. However, in analyzing the refractive status of our patients with angle-closure in our study, we found there was an almost equal distribution of myopes (37.2%) to hyperopes (35.8%). This may be due to our small study population which has a similar distribution of non-Chinese to Chinese. Hence, as shown in our study myopia in angle closure is not as rare as was previously believed.

The rate of high myopia among all angle closure subjects has been reported to be between 1.6% to 2.6%[8,14]. A study by Lowe[8] reported that 5.5% (7 of 127 eyes) of patients were myopes and 1.6% (2 of 127 eyes) had high myopia (≤6.0 D). Another study by Chakravarti and Spaeth[21] reported a high myopia rate of 1.9% of 322 angle-closure patients. These studies differ in the population that was studied. Although our study was based on 137 patients with complete biometric records, the rate of high myopia (2.2%) among all angle-closure patients was comparable to other studies.

Interestingly, we also found that the ACD was shallower in myopes compared to hyperopes and emmetropia but the AL was not significantly different between groups. This is not surprising as smaller anterior segments, namely a shallower anterior chamber width, as measured by optical coherence tomography, have been found in Asian eyes[29]. This was in

contrast to the study by Yong *et al*[14], where myopic angle-closure glaucoma subjects had longer axial and vitreous cavity length but the ACD was similar in all groups. Our subjects may have lenticular myopia or underlying cataract but the lens thickness measurements were not available in our patient record.

Epidemiologic studies have shown a higher prevalence of myopia amongst Chinese compared to Western population[9,27-28]. Environmental factors are believed to induce elongation of the AL resulting in axial myopia[30]. In our study, despite a similar distribution of myopes to hyperopes amongst PACD, there were more myopia amongst Chinese compared to non-Chinese. Hence, angle-closure is not uncommon in myopes especially in individuals with inherent shallow anterior chamber dimensions as seen in a proportion of Chinese. This supports the current thinking that ACD dimension is an important risk factor in the development of angle-closure glaucoma.

In the study by Liza-Sharmini *et al*[23-24], both eyes of the study subjects were included into the study and assessed individually, 27.8% to 30.4% was found to be blind from PACG. In our study we found no patients blind as a result of PACG because we only studied the vision in the better eye as blindness was defined as having a best corrected vision of less than 3/60 or an inability to count fingers at 3 m in the better eye. Thus, the definition of blindness was different between the two studies. Another possible reason is that our study subjects are from an urban population who are better educated and where health care is easily accessible.

The strengths of this study lies in the spectrum of PACD that was studied. This includes PACS, PAC and PACG. Our study had an almost equal distribution of Chinese to non-Chinese despite the prevailing racial distribution in this country. Among the limitations of our study is that it is a retrospective study. Therefore, a fair amount of essential data could not be retrieved or assessed. The study population was small and all parameters were confined to available data in the patient's chart. We also could not evaluate the lens thickness, lens vault, ciliary body thickness, iris dimension, anterior chamber width and volume between ethnic groups. These may be important parameters to assess as it will help us better understand the mechanism of angle-closure glaucoma in our population.

In conclusion, angle-closure glaucoma can occur in both myopes and hyperopes at an almost equal frequency. Myopic angle-closure glaucoma is not rare and myopia is not a protective factor against angle-closure as was previously believed. Importantly, increase public awareness and education are essential in early detection and treatment of glaucoma.

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Conflicts of Interest: **Mohamed-Noor J**, None; **Abd-Salam D**, None.

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